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THE PHILIPPINE

JOURNAL OF SCIENCE

C. BOTANY

VOL. XII JANUARY, 1917 No. 1

THE APPLICATION OF PHOTOCHEMICAL TEMPERATURE COEFFICIENTS TO THE VELOCITY OF CARBON DIOXIDE ASSIMILATION

By WILLIAM H. BROWN and GEORGE W. HEISE

(From the College of Liberal Arts, University of the Philippines, and from the Bureau of Science, Manila, P. I.)

THREE TEXT FIGURES

The van't Hoff principle,[1] which states that the rate of most chemical reactions at ordinary temperatures (between 0° C. and 180° C.) is approximately doubled or trebled for each increase of 10° C. in temperature, has been applied to many processes taking place in living organisms. Its application to plant processes has been emphasized by Blackman,[2] while Loeb and his coworkers [3] have discussed its relation to many processes in animals. Kanitz [4] has written a monograph on the relation between temperature and life processes. We have not been able to consult this book. Denny [5] in reviewing it says:

> Consideration is given first to the effect of temperature upon the rate

[1] Van't Hoff, J. H., Studien zur chemischen Dynamik (revised by Cohen, E.) (1896) 129: "* * * eine Temperaturerhöhung um 10 Grad verdoppelt, resp. verdreifacht die Reaktionsgeschwindigkeit."

[2] Blackman, F. F., The metabolism of the plant considered as a catalytic reaction, *Science* N. S. 28 (1908) 628–636.

[3] For a list of references on this subject, see Loeb, J., et al., *Science* N. S. 28 (1908) 645–648; also Kanitz, A., *Zeitschr. Elektrochemie* 13 (1913) 707, and *Zeitschr. Phys. Chem.* 70 (1910) 198.

[4] Kanitz, A., Temperatur und Lebensvorgänge (1915).

[5] Denny F. E., Bot. Gazette 62 (1916) 156.

of chemical processes. It is found that in general the latter follow the van't Hoff law, * * *.

Livingston and Livingston [4] in discussing these problems make the following statement:

> In much of the work that has been published on vital temperature coefficients, relatively simple physiological processes have been considered, and it seems allowable to conclude, at least tentatively, that most of the elementary chemical processes of living things go on according to the principle of van't Hoff and Arrhenius, and that such processes possess temperature coefficients, within the ordinary limits of environmental temperatures, of an order of magnitude of from about 2.0 to about 2.5. This may be regarded as a fundamental principle in physiology.

The consensus of opinion on this subject is that the principle applies only within certain limits and not at minimum and maximum temperatures for the processes concerned.

Photosynthesis is one of the plant processes that is usually cited as following the van't Hoff principle. However, since carbon dioxide assimilation is dependent on light, it is to be expected that the temperature coefficients will be similar to those of photochemical reactions, rather than to those of ordinary chemical processes. Photochemical reactions, almost without exception, have much smaller coefficients than those required by the van't Hoff principle. The ratios for the velocities of photochemical reactions for 10° intervals, given in a table by Plotnikow,[7] are between 1.00 and 1.42. Sheppard [8] gives a less complete list with values between 1.00 and 1.34. It is interesting to note that Weigert,[9] in his comprehensive discussion of photochemical processes, mentions photosynthesis as one of two photochemical reactions that show unusually high coefficients.

This discrepancy appeared rather surprising and induced us to undertake a series of experiments for the further investigation of the question of the temperature coefficients of photosynthesis. The available literature, however, seemed to show so convincingly that photochemical temperature coefficients do hold for photosynthesis, that it seemed advisable to publish a discussion of the literature at the present time.

[4] Livingston, B. E., and Livingston, G. J., Temperature coefficients in plant geography and climatology, *Bot. Gazette* 56 (1913) 349–375.

[7] Plotnikow, J., Photochemische Studien. IV Über den photochemischen Temperaturkoeffizienten von Brom, *Zeitschr. Phys. Chem.* 78 (1911) 573.

[8] Sheppard, S. W., Photo-chemistry (1914) 304.

[9] Weigert, F., Die chemische Wirkung des Lichts, *Sammlung Chem. u. Chem.-Tech. Vorträge* 17 (1911–12) 183–296.

VAN AMSTEL'S WORK ON ELODEA

An attempt has been made by van Amstel [10] to determine the effect of temperature on the assimilation of carbon dioxide, when light is not a limiting factor. The plant used was *Elodea*. From experiments performed at temperatures of 24° and 36° C. with various intensities of light, van Amstel concluded that increasing the light beyond 2,000 Hefner-candles had no effect on the rate of assimilation.

A series of experiments was then performed with a light intensity of 2,482 Hefner-candles and temperatures of 24°, 36.5°, 40°, 42°, and 45°. At 36.5° the injurious effects of high temperatures apparently had not set in, but they were very evident at temperatures above 40°. From the curve showing the assimilation of carbon dioxide with increasing temperatures, van Amstel obtained a value of 1.26 for the temperature coefficient between 24° and 34°.

Concerning this coefficient she says:

> Now, at such temperatures for most of the physiological processes a higher temperature-coefficient is found. As a rule this even amounts to a value between 2 and 3, as in most chemical processes. By this circumstance it becomes very improbable that we really did determine the velocity of the assimilation-process itself.

Her chief reason for the above statement apparently is found in the deviation of the temperature coefficient from the van't Hoff ratio. Since, as we have shown, it is to be expected that the coefficients of photosynthesis are low, her objection fails. As a matter of fact, her experimental data show remarkably good agreement with one another, as is shown in Table I, in which we have added to the data in her summary [11] the corresponding temperature coefficients. In this and all succeeding determinations of temperature coefficients the following formula, given by Kanitz,[12] has been used:

$$\log Q_{10} = \frac{10\ (\log K_2 - \log K_1)}{t_2 - t_1}$$

in which

Q_{10} = temperature coefficient for an interval of 10° C.
K_2 = rate observed at temperature t_2
K_1 = rate observed at temperature t_1.

[10] Van Amstel, J. E., On the influence of temperature on the CO_2-assimilation of Helodea canadensis, *Rec. Trav. Bot. Neérl.* 13 (1916) 1–29.
[11] Op. cit. 25.
[12] Quoted by Denny, F. E., *Bot. Gazette* 62 (1916) 156.

TABLE 1.—*Velocities of assimilation of carbon dioxide at different temperatures (van Amstel, Table VI) and the corresponding temperature coefficients calculated for 10° C.*

Time of heating.	Velocity of assimilation at—			Temperature coefficient Q_{10}.	
	24° C.	36.5° C.	40° C.	24°–36.5°	36.5°–40°
Minutes.	*Milligrams oxygen per minute.*				
3	200	278	293	1.30	1.16
9	200	282	306	1.31	1.26
15	200	265	303	1.25	1.46
21	200	274	285	1.28	1.11
27	200	264	246	1.25	----------
Average				1.28	1.25

BLACKMAN AND SMITH'S WORK ON ELODEA

Blackman and Smith [13] have performed two experiments with *Elodea,* which are interesting in this connection. These experiments are summarized in our Table 2.

TABLE 2.—*Summary of experiments D and E of Blackman and Smith on Elodea.*

Experiment.	Initial temperature.	Final temperature.	Carbon dioxide assimilation at initial temperature.	Carbon dioxide assimilation at final temperature.
	°C.	°C.	*Grams.*	*Grams.*
D	7	21	0.0115	0.0252
E	13	21	0.0177	0.0226

In the first case the rate of assimilation was determined at 7°; then the temperature was raised to 21°, and another determination was made. The second experiment was similar to the first, the temperatures in this case being 13° and 21°. The light was the same throughout. Blackman and Smith in discussing these experiments say:

By experiment D we have established 0.0115 as the "specific temperature maximum" for the temperature of 7° C. and by E the value of 0.0177 for the temperature of 13° C.

[13] Blackman, F. F., and Smith, A. M., Experimental researches on vegetable assimilation and respiration. IX.—On assimilation in submerged water-plants and its relation to the concentration of carbon dioxide and other factors, *Proc. Roy. Soc. London* B 83 (1910–11) 389.

From these figures the authors calculated that the coefficient of increase for 10° was 2.05. This coefficient, those calculated from van Amstel's data, and the coefficients from the experiments of Blackman and Smith are brought together in Table 3. The steady fall in the coefficients as higher temperatures are reached is similar to that usually shown by vital phenomena. However, the coefficients are much smaller than those generally shown by physiological processes. The coefficients between temperatures of 13° and 40° are within the range of those for photochemical reactions. Table 3 shows that if the results were in the form of a curve the limits within which photochemical coefficients would hold could be extended, somewhat, in both directions.

TABLE 3.—*Coefficients of increase in the rate of carbon dioxide assimilation in Elodea with rises in temperature.*

[All coefficients are calculated on the basis of a rise of 10° C.]

Range of temperature.	Coefficient.	Calculated from data of—
°C.		
7–13	2.05	Blackman and Smith, p. 402.
7–21	1.75	Blackman and Smith, pp. 400, 401.
13–21	1.35	Do.
24–36.5	1.28	Van Amstel.
36.5–40	1.25	Do.

These experiments suggest that the temperature coefficients for photosynthesis in *Elodea* bear about the same relation to photochemical ratios that those of most vital phenomena do to the van't Hoff principle.

THE WORK OF KREUSLER ON RUBUS FRUTICOSUS

The work of Kreusler has been much quoted as showing the relation between temperature and assimilation. These papers are not available. Pfeffer [14] gives a curve showing the results. From this curve the coefficients for the rate of increase in assimilation have been calculated on the basis of a rise in temperature of 10°. The numbers may be slightly different from what they would have been if based on the actual figures, but they are certainly accurate enough for our purposes. The results are

[14] Pfeffer, W., Physiology of plants, 2d ed., translated by A. J. Ewart (1900) 337.

given in Table 4. They are of the same order of magnitude as those for *Elodea*.

TABLE 4.—*Coefficients of increase in the rate of carbon dioxide assimilation in Rubus fruticosus with rises in temperature (data of Kreusler).*

Temperature.	Assimilation.[a]	Temperature coefficients calculated for 10° intervals.
°C.		
2.3	4.3	----------
7.5	7.2	2.9
11.3	9.9	2.3
15.8	11.5	1.4
25.0	12.2	1.07
7.5-25	----------	1.35

[a] Figures for assimilation were obtained by interpolation from curve, and were corrected for respiration.

The coefficients with temperatures from 11.3° to 15.5° and from 15.5° to 25° are within the limits for photochemical reactions. The coefficient for the total range from 7.5° to 25° is 1.35, which is well within the limits for photochemical processes. The coefficient for the range between 15.8° and 25° is 1.07.

According to Matthaei [15] the greater part of the long and detailed investigation of Kreusler was devoted to a single shoot of *Rubus*. A part of her discussion is as follows (p. 51):

> If all the amounts of assimilation given in his paper be plotted out (fig. 1) in their chronological order, without regard to the temperatures, a curve is obtained, which is well worth detailed consideration. The general character is most decidedly that of a progressive fall in the amount of the assimilation, notwithstanding that the various temperatures occur in no particular order, but quite capriciously, and that the same temperature is often repeated. Thus, in this series, the amount of assimilation performed by the *Rubus* branch was largely a function of the time during which the experiment had lasted, and was not purely dependent on the temperature.

If this criticism is valid the work of Kreusler indicates a coefficient near 1.0 for a much larger range of temperatures than between 15.5° and 25°. In Matthaei's curve variations in temperatures between 11° and 25° appear to have little if any effect

[15] Matthaei, G. L. C., Experimental researches on vegetable assimilation and respiration, III. On the effect of temperature on carbon-dioxide assimilation, *Phil. Trans. Roy. Soc. London* B 197 (1905) 47–105.

on the assimilation, while the apparent effect of time is most marked in the latter experiments, which were with temperatures above 25° and where there is a decline in the rate of assimilation.

THE WORK OF PRJANISCHNIKOW ON TYPHA

The observation of Prjanischnikow [16] that the rate of assimilation in *Typha latifolia* in direct sunlight did not change with temperatures between 9.5° and 39° C. is in harmony with the results of the experiments previously mentioned. In diffused light he found a change in rate at different temperatures. The figures are not given in the review. The results from the experiments in direct sunlight indicate a temperature coefficient of about 1.0.

THE WORK OF LUBIMENKOW

Lubimenkow [17] has determined the carbon dioxide assimilation of five conifers and three deciduous trees at varying angles to direct sunlight and at temperatures of 20°, 25°, 30°, 35°, 38° C. No details concerning his method are given in the article quoted, but there are enough discrepancies in individual series to indicate that the experimental error was great. The average temperature coefficient calculated for the twenty-eight experiments for the interval 20°–30° C. was 1.4; for 25°–35° C. it was much lower.

THE WORK OF MATTHAEI ON CHERRY LAUREL

Matthaei [18] made an extensive study of the relation of temperature to carbon dioxide assimilation in the leaves of cherry laurel, *Prunus laurocerasus*, garden variety *rotundifolia;* and reached the conclusion that if sufficient light and carbon dioxide were present the assimilation increased rapidly with increasing temperature between the limits −6° C. and +37° C. In a subsequent paper Blackman [19] calculated that the ratio of increase in assimilation as expressed in Matthaei's curve for the 10° rise in temperature between 9° and 19° is 2.1. The statements that the van't Hoff principle applies to photosynthesis are

[16] Reviewed by Batalin in *Bot. Jahresbericht* 4 (1876) 897; see also Famintzin, A., in *Ann. Sci. Nat. Bot.* VI 10 (1880) 67–80.

[17] Lubimenkow, W., Variations de l'assimilation chlorophyllienne avec la lumiére et la temperature, *Compt. Rend. Acad. Sci.* 143 (1906) 609.

[18] Matthaei, G. L. C., Experimental researches on vegetable assimilation and respiration. III. On the effect of temperature on carbon-dioxide assimilation, *Phil. Trans. Roy. Soc. London* B 197 (1905) 47–105.

[19] Blackman, F. F., Optima and limiting factors, *Ann. Bot.* 19 (1905) 281–295.

usually based on these figures. Kanitz [20] holds that Matthaei's results show a temperature coefficient approximately that of the van't Hoff principle between 0° and 37° C.

The experiments of Matthaei apparently were done with great care, and the leaf temperatures and carbon dioxide absorption were measured with a high degree of accuracy. Measurements of light were much less exact, but Matthaei believed that the amounts used in the critical experiments were great enough so that light was not a limiting factor. The sources of light were two kinds of gas burners. Her unit light intensity was a small and arbitrary one, and no measure of its actual intensity is given. In a foot note Matthaei [21] gives the following discussion of the measurements of light:

> All the intensities of light subsequently used are expressed in terms of this unit intensity by making due allowance for alterations in distance and differences in the burners employed. Of course with a compound source of light such as an incandescent mantle, such a comparison of intensities makes no pretense to accuracy, but may serve as a rough guide to the relative amounts of light necessary for maximal assimilation at various temperatures, and is absolutely necessary for convenience of reference.
>
> It will soon also be made clear that knowledge of the exact intensity of light being used is not of critical importance in these investigations.

Some of the irregularities, which will be noted later, may be due to inexact measurements of light; but the general concordance of the results indicates that the measurements were fairly accurate. We believe, however, that errors in interpretation are responsible for the idea that the rate of assimilation increases rapidly for rises in temperature between 3° and 33° C. The rises in temperature were accompanied by increased intensities of light, and the latter factor appears to account for the changes in rate of assimilation.

The results of the experiments of Matthaei are given at the end of her paper in eleven tables.[22] The first deals with respiration and the others with photosynthesis. Tables II to IV contain experiments performed with unit intensity of light and at various temperatures. Each experiment usually consisted of from three to five readings. In these, as in the other tables,

[20] Kanitz, A., Über den Einfluss der Temperatur auf die Kohlendioxyd-Assimilation, *Zeitschr. Elektrochemie* 11 (1905) 689–90.

[21] Op. cit. 59.

[22] Since it will be necessary in this paper to make frequent reference to Matthaei's tables as well as to our own, we shall designate the former by Roman numerals, as in the original text, the latter by Arabic numerals.

the experimental data are given in full, and the results are calculated on the basis of real assimilation for 50 square centimeters of leaf and for one hour. The results of these three tables are summarized in Table 5 of the present paper, and plotted in fig. 1. The numbers from each table are plotted separately.

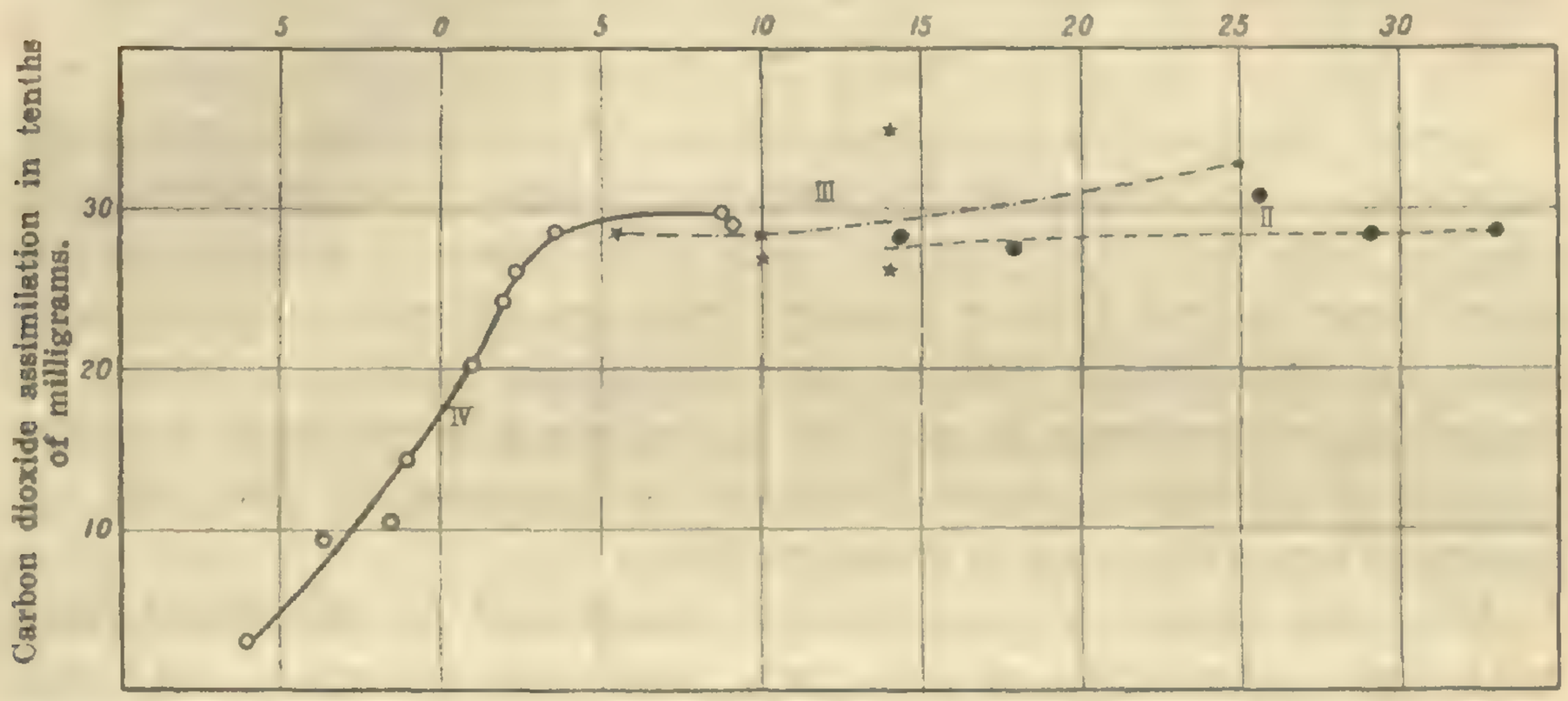

FIG. 1. Relation of carbon dioxide assimilation and temperature at unit light intensity.

TABLE 5.—*Assimilation experiments at low and medium temperatures with unit intensity of light (Matthaei, Tables II–IV).*

Table.	Experiment No.	Date.	Temperature.	Readings.	Average CO_2 assimilation calculated for 50 sq. cms. and 1 hour.
		1912.	°C.		*Grams.*
II	V	Jan. 29	14.4	5	0.00282
	VI	Jan. 30	18.0	4	0.00274
	VII	Jan. 25	25.7	4	0.00307
	VIII	Jan. 23	29.1	4	0.00284
	IX	Feb. 1	33.1	2	0.00285
III	X	Feb. 8	5.5	3	0.00285
	XII	Feb. 7	10.1	3	0.00282
	XI	Feb. 6	10.2	3	0.00268
	XIV	Feb. 11	14.0	2	0.0026
	XIII	Feb. 5	14.2	3	0.00348
	XV	Feb. 10	25.0	3	0.00327
IV	XXI	Mar. 1	−6.0	2	0.0003
	XXII	Feb. 24	−8.6	3	0.00093
	XXIV	Feb. 17	−1.5	3	0.00105
	XXIII	Feb. 20	−1.0	3	0.00143
	XVI	Feb. 27	+1	3	0.00202
	XVII	Mar. 2	+2	3	0.00242
	XVIII	Feb. 13	+2.4	3	0.0026
	XIX	Mar. 7	3.6	3	0.00285
	XX	Mar. 4	8.8	2	0.00297
	XIX	Mar. 7	9.1	3	0.0029

The figure is similar to that given by Matthaei (p. 65) and shows that as the temperature rises from —6° to +3° there is a rapid increase in the rate of assimilation. Beyond this point the rate is increased very little if at all by higher temperatures. In regard to this part of the curve Matthaei (p. 6, par. 4) says:

> Individual differences in the readings of any one series are hardly greater than the experimental error obtained in the actual experiments.

The part of the curve below 3° shows very much higher coefficients than would be called for according to the van't Hoff principle. At these temperatures many plant processes are just coming into activity. Under such conditions it would not be surprising to find that a general ratio would not hold for any particular function. The present discussion will be confined to temperatures between 3° and 33° C., where it is believed that the results of Matthaei show little or no increase in the rate of assimilation with rises in temperature.

The next series of experiments mentioned by Matthaei deal with light intensities of one, two, four, and six units with various temperatures. The details are given in Table V of her publication, and are summarized in Table VI. Her summary is copied in our Table 6.

TABLE 6.—*"Summary of the experiments in Table V setting forth the ratios of the assimilation with the different intensities of light." (Matthaei Table VI.)*

Experiment No.	Date.	Temperature.	Real assimilation 50 sq. cms. in 1 hour.			
			Light intensity.			
			1.	2.	4.	6.
	1902.	°C.	*Grams.*	*Grams.*	*Grams.*	*Grams.*
XXVIII	May 3	0.4	0.00175	0.0020		
XXIX	Apr.12–13	3.3	0.00225	0.00385		
XXX	Apr.13–14	9.2	0.00205		0.00365	
XXXI	Apr. 25	11.4	0.0022		0.00465	0.00505
XXXII	Apr. 26	11.4	0.0022	0.00375		
XXXIII	Apr.24–25	11.4			0.00465	
XXXIV	Apr. 29	25.2	0.00215		0.00615	*0.0063
XXXV	Apr. 30	25.2		0.00385		
XXXVI	Apr.19–20	24.3	0.00185		0.00485	

* This figure does not appear in Matthaei's Table V.

The column for unit light intensity shows, as did the previous experiments, that with this light there was no change in the rate of assimilation with the temperatures that were above 3° C.

The rate of assimilation is much less than in the former experiments with the same intensity of light. This difference is emphasized by Matthaei and apparently is due to the time of the year, the former experiments having been performed much earlier, as will be seen from the dates given in the tables.

The column for light intensity of two units shows a higher rate of assimilation than that for one unit. There is, however, no difference in the rate for different temperatures above 0.4°.

The results with light intensity of four units are not so clear. The two determinations at 11.4° and the one at 24.8° are very similar, being respectively .00465 and .00485. The figure for 25.2° is .00615. Evidently there must be a considerable experimental error either in the result for 24.8° or for 25.2°, as a rise of 0.4° can hardly account for the difference in the results. Matthaei discards the figure for 24.8° because (footnote p. 27) the results in experiment 36 for light intensities of one and four units "are far too small in comparison with the other experiments." However, the results for one unit are well within the limits of experimental error indicated in Table I. The rates of assimilation for temperatures of 9.2° and 11.4° are also very different. It will be seen that the figure for light intensity of four units at 9.2° is less than for light intensity of two units at 8.8°. The results for light intensity of four units are plotted in fig. 2. The form of the curve seems to show that the results are such that no reliable conclusions can be drawn from them. If the figures for 11.4° and 24.8° are correct, there is very little or no rise in the rate of assimilation; if the results for 9.2° and 25.2° are reliable, there is a considerable rise. As the measurements of light were not exact, it is possible that the irregularities in the results are due to differences in the intensity of light. It will be noted that experiments 13 and 14 (Table 1) at 14.2° and 14.0° with unit light intensity show very different results. In this case, however, there are enough other experiments to show that the results are due to experimental error.

The discussion of the results with light intensities of four units is important, because it is by them that Matthaei attempts to prove that light was not a limiting factor in obtaining her result for assimilation at a temperature of 9°. The figures for light intensity of four units should be judged by their relation to the general results. In no other case will it be necessary to call into question the reliability of any figure to show that Matthaei did not eliminate the probability of light being a controlling factor at any temperature between 3° and 33°.

There were two determinations of assimilation with light in-

tensity of six units, one at 11.4° and the other at 25.2°. The figure for 25.2° is slightly higher than for 11.4°. An examination of our Table 5 will show that the percentage of increase is within the possible limits of experimental error. The coefficient for a rise of 10° as calculated from these figures is 1.17.

We will now examine Matthaei's argument more in detail.

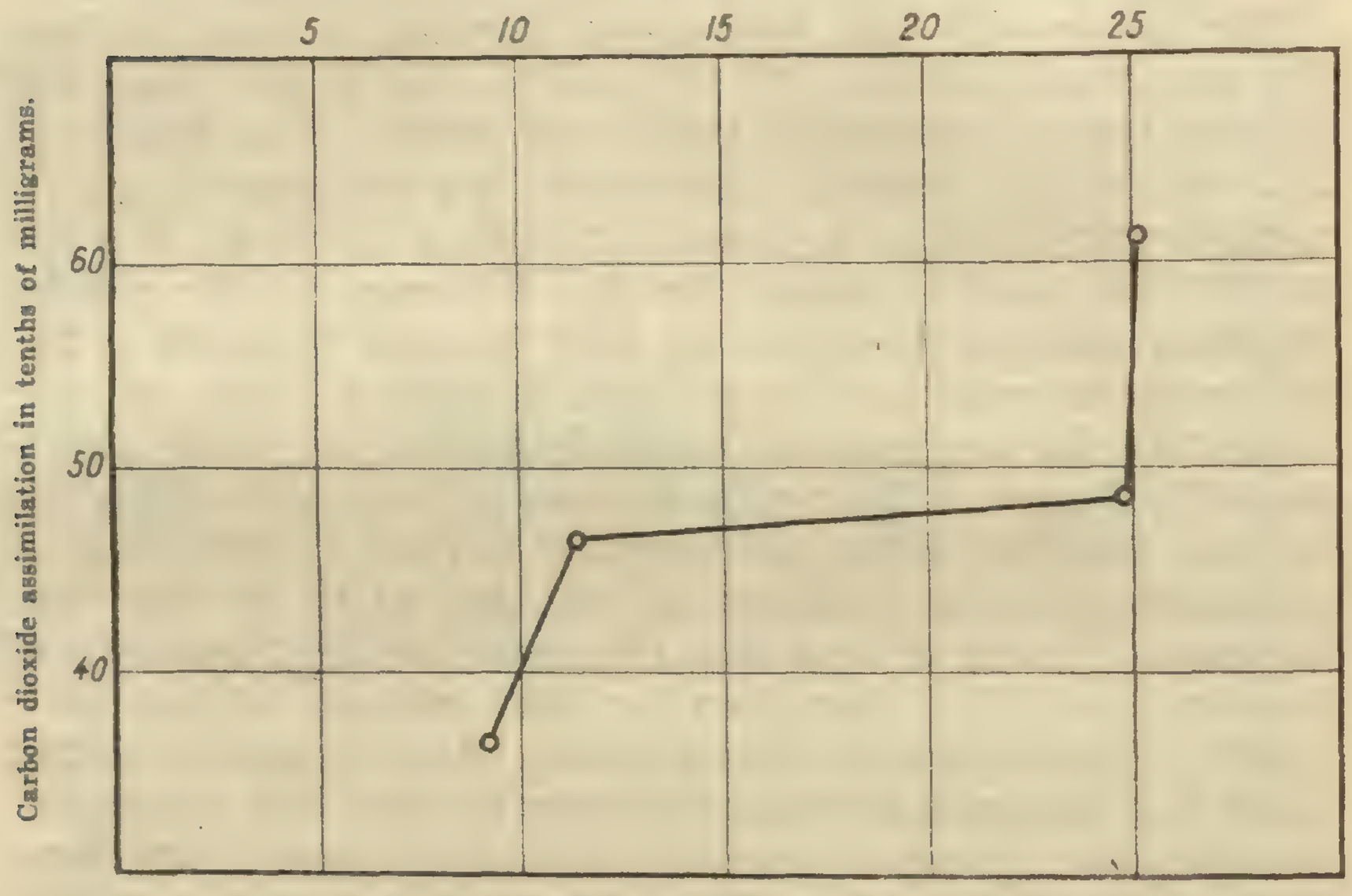

FIG. 2. Results of Matthaei with four units of light.

The following quotation [22] gives Matthaei's point of view in regard to light in her experiments:

> The limiting assimilation maximum, fixed directly by any given temperature, can then only be arrived at when the light is adequate for the decomposition of the amount of CO_2 in question, and when, also, of course, that amount of CO_2 is freely available. Therefore, to reach these maxima for the higher temperatures, more light must be employed, and the evidence that is to be looked for to show that the limit is reached, and that the light really is sufficient, will be of the nature of showing that, at the given temperature, increase of light no longer augments the assimilation.

In this paper an attempt will first be made to show that in her work she has not proved that the limit was reached, and afterwards to demonstrate that the increase which she finds in the rate of assimilation is largely or entirely due to changes in the intensity of the light. Matthaei's proof that light was not a

[22] Op. cit., p. 68, par. 3.

limiting factor in the critical experiments begins as follows (p. 70, par. 2):

> When the intensity is doubled, the assimilation at 0.4° C. is unaltered, but an increase is produced at the other temperatures, numbers almost identical being obtained for all of these.

The temperature is below that which we are considering. It may be said, however, that with unit intensity of light the result at 0.4° is very similar to those obtained at all higher temperatures and so is greater than would be expected from the more complete results recorded in Table 1 and plotted in fig. 1. This figure shows an increase in assimilation of considerably more than 50 per cent between 0.4° and 3.6°. Doubling the intensity of light did, however, increase this apparently too high result in Table 2 for unit intensity of light at 0.4°.

The paragraph, under discussion, continues:

> When four times the light is used we find a similar phenomenon. The assimilation at 9° C. is no greater than that corresponding to twice the light, for the temperature exerts its limiting effect and the leaf can assimilate no more. At 11° C. a higher number is obtained, which, however, is not so great as that obtained at 25° C., showing that the leaf can make use of more light than is given by L. In. = 2, but it cannot use all that of L. In. = 4.

The above conclusion is reached by discarding the figure for light intensity of four units and 24.8° and regarding those at 9.2° and 25° as accurate. If the single low figure at 9.2° is not reliable, her argument fails. It has already been shown that these figures cannot be regarded as reliable enough to have positive conclusions drawn from them.

The percentage of increase between the figure for 9.2° and the one for 11.4° and four units of light is, moreover, within the possible limits of experimental error indicated in our Table 5, experiments 13 and 14. Such differences are probably not due to errors in measuring the carbon dioxide absorbed, but might well be due to variations in leaves and light. Under such conditions one experiment is certainly not a sufficient basis for conclusions.

Continuing Matthaei says:

> Sixfold light gives practically the same results as fourfold light for 11° C., showing that the maximum has been attained.

If the percentage of increase is calculated it will be found that at 11.4° raising the light from one to two units, or 100 per cent, increased the assimilation 70 per cent; raising the light from

two to four units, or 100 per cent, increased the assimilation 24 per cent; raising the light from four to six units, or 50 per cent, increased the assimilation 8.6 per cent. This certainly shows that at 11°, four units is not the maximum amount of light that the leaf could use in assimilation. Nor is there any proof that the maximum was attained with six units of light, for throughout Matthaei's experiments there is for each increase in light intensity a rise in assimilation; but this is, per unit of light, progressively smaller.

In Matthaei's curve the difference in the results obtained by increasing the light from two to four units at 11°, over those caused by a rise from four to six units, is exaggerated by a misplacement of the points for these figures.

In view of the fact that four units of light are certainly not the maximum that the plant can use at 11.4°, it seems hardly reasonable to suppose that two units could have been at 9°, as is assumed to be the case by Matthaei on the basis of her apparently unreliable figures for four units.

The figures which we have just discussed for 9° and 11.4° are used by Matthaei for the lower temperatures above 0.0° in constructing her final curve. Before considering the figures for the higher temperatures, we will take up the results with light intensity of eight units. These are given in Table VII of the original publication, and are summarized in Table 7 of the present paper.

TABLE 7.—*"Assimilation experiments at medium and high temperatures with light of eightfold intensity (L. In.=8). Two ordinary incandescent burners at low gas pressure."* (*Matthaei, Table VII.*)

Experiment No.	Date.	Temperature.	Assimilation per hour per 50 sq. cms.
	1903.	°C.	*Grams.*
XXXVII	Mar. 4	11.0	0.0072
XXXVIII	Jan. 29 and 30	25.4	0.0128
XXXIX	Jan. 31	25.3	0.0125
XL	Feb. 4	32.1	0.01295
XLI	Feb. 5	32.2	0.0130
XLII	Feb. 2	38.3	0.0115
XLIII	Feb. 3	38.3	0.0130
XLIV	Feb. 9	40.9	0.0078
XLV	Feb. 10	40.9	0.0080
XLVI	Feb. 6	42.9	0.0040
XLVII	Feb. 7	42.9	0.00355

These experiments were not used in Matthaei's final curve for assimilation at different temperatures. With the exception of the first one they were performed in the last part of January or early in February, when the leaves were more active than at the time of the experiments on which the final curve is based. Varying the temperature between 25.3° and 38.3° seems to have had no appreciable effect on the rate of assimilation. Higher temperatures were detrimental. The figure for 11.0° is lower than for temperatures between 25.4° and 38.3°. This can readily be explained as due to differences in the seasonal activity of the leaves. Matthaei (p. 83, par. 5) says:

> The maximal assimilation of a leaf at 30° C. might be .0240 gramme in February, and in April be .0136 gramme, but a reduction in temperature to 11° C. would cause the same proportionate decrease in both cases.

No evidence for the correctness of the latter statement is given. There is, then, no reason for assuming, as Matthaei does, that with eightfold intensity of light there is a rise in the rate of assimilation between temperatures of 11° and 25°. These experiments, indeed, agree with all of the previous ones in which reliance can be placed, in showing that with a given intensity of light, variations in the temperature above 3° produced no appreciable effect.

We will now consider the figures for higher temperatures in Matthaei's curve. These are presented in Table XI of her publication and are summarized in Table 8 of the present paper. They are copied in greater detail than any of the previous experiments, as the figures for assimilation at 37.5° and 40.5° decrease markedly with each successive reading. The results for 37.5° will be discussed later. The still higher temperature, 40.5°, is evidently harmful and of no interest here.

The first figure is that for 15°. Matthaei's discussion of this point is as follows (p. 78, par. 7):

> Experiment LVI., 15° C.—The intensity of the light employed in this experiment was thirteen times unit intensity. The lowest temperature of the bath attainable was 11° C. (that of running water at that time of year), and, in consequence, the excess of light must not be great enough to raise the temperature of the leaf more than 4° C.
>
> Under these conditions the leaf decomposed .0070½ gramme CO_2 per hour. Now it will be seen that in Experiment XXXVII, at 11° C., the intensity of the light used was eight times unit intensity, *i. e.*, a little more than half that available in this experiment. The amount of CO_2 decomposed per hour was, however, .0072 gramme, and therefore this leaf at 15° C. must be exposed to nearly twice the light necessary for the assimilation which it has actually performed.

TABLE 8.—*Experiments showing assimilation at temperatures between 15° C. and 40° C. (Matthaei, Table XI.)*

Experiment No.	Date.	Temperature.	Light intensity.	Area.	Apparent assimilation per hour.	Respiration per hour.	Real assimilation calculated for 50 sq. cm. and 1 hour.
	1903.	°C.		Sq. cm.	Grams.	Grams.	Grams.
LVI	Apr. 6	15.0	13	37.0	0.0050		
					0.0046		
					0.0050		
					0.00475		
					a0.00485	a0.00035	a0.00705
LVII	Apr. 4	23.7	26	42.0	0.0065		
					0.0080		
					0.0084		
					0.0076		
					a0.0076	a0.0009	a0.0101
LVIII	Apr. 3	30.5	45	46.0	0.0134		0.0157
					0.0116		
					0.0106		
					0.0099		
					a0.01135	a0.00115	a0.0136
LIX	Apr. 7	37.5	45	36.0	0.0154		0.0237
					0.0106		
					0.00795		
					0.0059		
					a0.0100	a0.0019	a0.0163
LX	Apr. 9	40.5	45	38.5	0.0099		0.0149
					0.0075		
					0.0060		
					0.0020		
					a0.0063	a0.0016	a0.0102

a Mean values per hour.

In Table 9 the two experiments are compared. In experiment 37 the temperature is lower and the light less intense than in experiment 56, while the assimilation is slightly greater. The difference in temperature between these two experiments would, according to Matthaei's final curve, account for an increase in assimilation from 48 to 70 milligrams of carbon dioxide. Then, according to Matthaei's argument (p. 79), if the leaf were "exposed to nearly twice the light necessary for the assimilation which it has actually performed," it was also exposed to a higher temperature than was necessary for this assimilation. Obviously, the only conclusion that can be drawn from a comparison of these experiments is that the leaf used in experiment 56, performed in April, was less active than the one used in experiment 37, done in March.

TABLE 9.—*Comparison of experiments 56 and 37 of Matthaei.*

No. of experiment.	Date.	Temperature.	Light intensity.	Assimilation.
		°C.		
37	Mar. 4	11	8	0.0072
56	Apr. 6	15	13	0.00705

Matthaei uses a similar argument for a temperature of 23.7° (p. 80, par. 3):

> The value of the assimilation is .0101 gramme per hour, less than the amount (.0128) induced in Experiment XXXVIII., Table VII., by one-third the light. Here again, therefore, there is no doubt that we are dealing with the maximal assimilation for 23°.7 C.

Experiment 57 was performed in April, and 38 in January, when the leaves are known to be much less active. If the latter experiment is plotted with Matthaei's final curve, in which the former is used, the point for experiment 38 will be found to be considerably above the curve, showing that the argument for experiment 57 contains exactly the same fallacy as that for experiment 56.

Matthaei's reasoning in the case of a temperature of 30.5° is as follows (p. 80, par. 5):

> To show that here the assimilation is maximal we must turn to the experiments in Table VIII. There the leaf chamber was in exactly the same position in the bath, the same burners were used, but were placed several millimeters further away. The value of the assimilation induced by this less intense light was, however, .0249 gramme per hour, showing that the light employed in the present experiment would have been sufficient to produce more assimilation than this, and therefore the value of .0136 gramme per hour must represent the maximal assimilation at this temperature.

Here we have a comparison between experiments performed in April and in February. The fallacy is obvious from the discussion of experiments 56 and 57.

We have seen that Matthaei has failed to show that light was not a limiting factor in any of her experiments with temperatures between 3° and 33.5°. We will now inquire into the effect of light in these experiments. In fig. 3 all of the assimilation values obtained with temperatures within the above limits, in Tables 6 and 8, are plotted with reference to light intensity. These tables contain all of the numbers used by Matthaei in plotting this part of her final curve. In fig. 3 they

are plotted independently of temperature, but the temperature at which the experiment or experiments were performed is placed beside each point. The curve passes very near the point that represents the three similar values obtained with a light intensity of four units and about midway between the other two values. At light intensity of six units it is drawn between the two figures for assimilation. The results give a smooth curve, which shows that with each increase in light intensity there is a rise in assimilation, but a rise that is less and less per unit of light for each increase. This would indicate at once

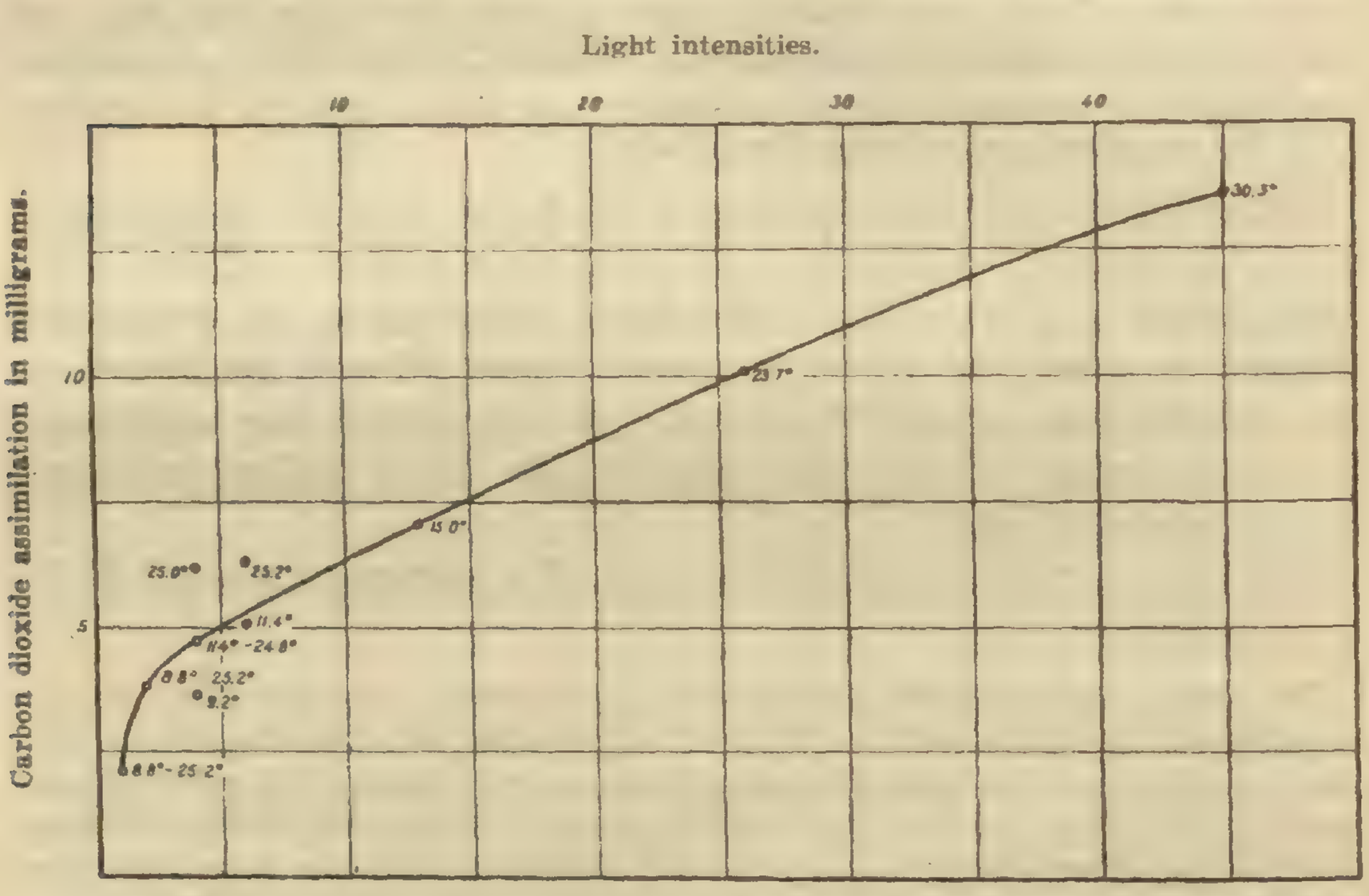

FIG. 3. Relation of light intensity and carbon dioxide assimilation in cherry laurel.

that we might be dealing with a curve of light and not of temperature. The highest rise for a given change in light intensity is obtained when the light is increased from one to two units. This rise is certainly independent of temperature.

It may be noted that a curve for different light intensities between 1 and 26, at a temperature of 24°, would be exactly the same as that in fig. 3 for the same intensities of light. The figures for light intensity of one, two, and twenty-six units would be the same, while the actual figure in Table 2 for light intensity four and 24.8° C. would be exactly on the curve. An examination of fig. 3 shows that the other numbers would fall in line.

The whole curve in fig. 3 is apparently the same as a curve for different light intensities at 30.5°. In Table 5 it was shown that with unit intensity of light, increasing the temperature

from 3.6° to 33.1° had no appreciable effect on assimilation. Therefore, we may assume that the value of unit intensity of light at 30.5° would be the same as in fig. 3. An examination of Table 6 indicates that this would also hold for light intensity of two units. It is probable that the intermediate points would also be the same.

Since the curve for the different light intensities at the highest temperature would, apparently, be the same as that in fig. 3, we would seem to be justified in assuming that the different rates of assimilation, shown in fig. 3, are due to changes in the intensity of the light; and that temperature was nowhere a limiting factor.

An examination of Tables 5 to 7 will show that with a constant intensity of light and temperatures above 3° the coefficient of increase in assimilation with a rise of temperature of 10° is 1.00 or slightly more than this for the three series with unit intensity of light (fourteen experiments) in Table 5, for light intensitiy of eight units (six experiments between 25.3° and 38.30°) in Table 7, and for one (six experiments) and two (three experiments) units in Table 6. The two figures in Table 6 for six units give a coefficient of 1.17. The highest and lowest values for assimilation with four units in Table 6 show a coefficient of 1.38; although, as we have seen, the figures on which this is based cannot be regarded as reliable, and the coefficient probably should be lower. The above coefficients are within the range that would be expected for a photochemical reaction.

With increasing light intensities the rise in assimilation per unit of light was less and less, indicating that the reaction velocity is not directly proportional to the light intensity. That this is in agreement with the results of Pantanelli [23] on *Elodea* is very apparent, if the values are taken from his curve in Table IV.

These results are quite in keeping with those of nonvital photochemical reactions, many of which show great deviations [24] from a direct proportionality between light intensity and reaction velocity. Increasing the light increased the assimilation but apparently had little or no effect on the temperature coefficients. With continued increases in light intensity we apparently must reach a point where rises in the rate of assimi-

[23] Pantanelli, E., Abhängigkeit der Sauerstoffausscheidung belichteter Pflanzen von äusseren Bedingungen, *Jahrb. Wiss. Botanik* 39 (1904), 167–228.

[24] Weigert, F., Die chemischen Wirkungen des Lichts, *Sammlung Chem.-Techn. Vorträge* 17 (1912) 264.

lation are too slight to be measured, although, theoretically, they may occur. Reinke [25] and Pantanelli [26] both found a light intensity, about equal to direct insolation, beyond which further increases in illumination augmented assimilation very little or not at all. There is, however, no reason to believe that at such intensities the order of the temperature coefficients would be changed. The low coefficient obtained by van Amstel with light of such high intensity that further increase in illumination caused no measurable increase in assimilation is in harmony with this view. A photochemical reaction, with such intensities of light, would still be photochemical and should show photochemical coefficients. It seems reasonable to assume, therefore, that the temperature coefficients for assimilation in cherry laurel, for temperatures between 3° and 33° (and perhaps even higher temperatures), is either 1.00 or a slightly larger figure, rather than 2 or more.

Tables VIII and IX in Matthaei's publication deal with preliminary experiments in which the temperature of the leaf was not determined. These are not used by Matthaei in building her curve and are of no interest here.

Table X is headed, "An experiment with a Keith high pressure burner showing the unavoidable rise in the assimilation maximum that results, with each augmentation of the light intensity, from the decided increase of internal leaf temperature that the radiation produces, in spite of the bath temperature being kept constant throughout." The results of this table are summarized in Table 10 of the present paper.

TABLE 10.—*Summary of Table X (Matthaei).*

Experiment No.	Date.	Temperature.	Light intensity.	Real assimilation per hour per 50 sq. cms., in grams.
	1903.	°C.		
LV	Mar. 12–15	18.5	18.5	0.0100
		15	9.25	0.00685
		13	4.75	0.00555
	Mar. 13	13	4.75	0.0059
		11	2.87	0.0039
		11	1.47	0.0024
	Mar. 15	11	1.47	0.00305
		11	0.73	0.00185

[25] Reinke, J., Untersuchungen über die Einwirkung des Lichtes und die Sauerstoffausscheidung der Pflanzen, *Bot. Zeit.* 41 (1883) 697.

[26] Pantanelli, E., *Jahrb. Wiss. Bot.* 39 (1904) 167–228.

The changes in velocity are readily explained as due to changes in the intensity of the light. When the values for assimilation are plotted with reference to light intensity they form a curve similar to that in fig. 3.

Experiment 59 (Table 8) at a temperature of 37.5° and light intensity of forty-five units, shows a marked increase in the rate of assimilation over that shown in experiment 58 with the same light and a temperature of 30.5°. Table 8 shows that the rate of assimilation at 37.5° fell off very rapidly with successive readings. This shows that at this temperature there are complicating side reactions of considerable magnitude, so that it is not to be expected that a photochemical ratio would hold. The importance of side reactions will be shown in another connection. Moreover, one experiment under extreme conditions cannot be regarded as reliable when we consider the magnitude of the experimental error with medium temperatures. For the above reasons we have thought it best not to attempt to draw any conclusion from the experiment at the temperature of 37.5°. It is interesting to note that experiments 42 and 43 (Matthaei, Table VII) with light intensity of eight units and temperature of 38.3° do not show the decrease in the rate of assimilation that is seen in experiment 59.

BLACKMAN AND MATTHAEI ON HELIANTHUS

The work of Blackman and Matthaei[27] has been quoted as showing a high temperature coefficient for *Helianthus*. Their statement is as follows:

> For a rise of 10°, the increase with cherry-laurel is 2.1 [0.0038 at 9° and 0.0080 at 19° C.], while with *Helianthus* it is certainly bigger, perhaps 2.5, but we have not exact data yet for giving the coefficient a precise value.

The coefficient for cherry-laurel is based on Matthaei's work, which we have previously discussed. The only basis that we can find for the one for *Helianthus* is a curve (in fig. 2, p. 414) that represents the initial assimilation-maximum for *Helianthus* at different temperatures. This curve is based on four figures that they give on page 413. In Table 11 we have selected from the full experiments the data on the readings mentioned. It will be seen that the lowest temperature was obtained while it was raining and the highest with brilliant sun. It is not evident why the changes in the rate of assimilation cannot be explained as

[27] Blackman, F. F., and Matthaei, G. L. C., Vegetable assimilation and respiration IV. A quantitative study of carbon-dioxide assimilation and leaf-temperature in natural illumination, *Proc. Roy. Soc. London* B 76 (1905) 402–460.

due to variation in light intensity, especially since it is evident from their individual experiments that fluctuations in light intensity are accompanied by marked changes in assimilation.

TABLE 11.—*Experiments of Blackman and Matthaei on Helianthus.*

Experiment No.	Temperature.	Assimilation.	Time.	Light conditions.
	°C.		a. m.	
X	18.0	0.0090	11.30–12.00	Raining.
XI	20.8	0.0109	11.10–11.40	Cloud, haze.
	20.6			Heavy cloud.
XI	22.3	0.0131	10.40–11.10	10.48, thin cloud.
				10.52, slight rain.
				11.00, cloud, haze.
XVI	30.0	0.0290	8.5 – 9.5	Brilliant sun.

GENERAL DISCUSSION

Since carbon dioxide assimilation is effected by light, it is to be expected that the temperature coefficients should have the magnitude ascribed to photochemical, rather than that ascribed to ordinary chemical, reactions. It should be emphasized that, owing to side reactions, after effects, and other disturbing factors, the exact determination of the temperature coefficients even of comparatively simple photochemical reactions is very difficult. For example, the photobromination of toluol was first found [28] to have a temperature coefficient of 1.85. It has been shown,[29] however, that this coefficient was merely the resultant obtained from a combination of photochemical and ordinary chemical reactions, the former having a low, the latter a comparatively high, coefficient.

From the above it is evident, that with so complicated a reaction as carbon dioxide assimilation, the fact that the temperature coefficient is within the limits of photochemical coefficients over wide ranges of temperature is very significant.

A discussion of the temperature coefficient of carbon dioxide assimilation, if all disturbing factors were removed, is in the realms of speculation, but may be of interest. Plotnikow [30] has shown that photochemical reactions can be arranged in three groups in each of which all temperature coefficients are very similar. From this he assumes that there are in reality only

[28] Bruner and Czarnecky, *Bull. Acad. Sc. Cracovie* (1910) 516, quoted by Plotnikow, J., *Zeitschr. Phys. Chem.* 78 (1911) 573.

[29] For a discussion of this point, see Plotnikow, loc. cit.

[30] Loc. cit.

three photochemical coefficients, and that these are 1.04±0.03, 1.20±0.03, and 1.39±0.03.

If carbon dioxide assimilation has one of these coefficients, the work of Matthaei on cherry laurel and that of Prjanischnikow on *Typha,* in direct sunlight, would indicate that it would be 1.04. The coefficient, 1.07 from Kreusler's work on *Rubus,* for temperatures between 15.5° and 25°, is in close agreement. The coefficients for *Elodea* are higher, but this may be due to insufficient data or complicating reactions.

Apparently, photochemical coefficients hold for lower temperatures in cherry laurel than in *Elodea.* The low temperatures at which they hold for the former plant may be connected with the fact that this plant is an evergreen and that the experiments were performed during the colder months of the year. In other words, this plant apparently is adapted to carry on photosynthesis in a normal manner at low temperatures. The following statement made by Ewart [31] is interesting in this connection:

> It appears that all evolution of oxygen ceases in tropical plants between 4° C. and 8° C., in warm temperate, subtropical, and water-plants between 0° C. and 2° C., whilst in cool temperate, arctic, and alpine plants assimilation only ceases when the plants are frozen, *i. e.* at a few degrees below 0° C.

A summary of the temperature coefficients of carbon dioxide assimilation calculated from the work discussed in this paper, together with the temperature ranges over which they retain the order of photochemical coefficients, is shown in Table 12. It is evident that in many cases the limits could be greatly extended in both directions, without bringing the coefficients outside the range of photochemical, much less within the range of ordinary chemical constants. We have, however, limited ourselves strictly to the temperatures for which experimental data are at hand, and in which there can be no doubt of the order of magnitude of the coefficients.

It is not surprising that carbon dioxide assimilation should show high coefficients at low temperatures, when we consider the possibility of complicating side reactions and the very high ratios shown by many physiological processes at similar temperatures. Keeping in mind the possibility of side reactions, the different methods employed by various investigators, and the corresponding experimental errors, the lack of perfect agreement in the coefficients listed above does not appear serious.

[31] Ewart, A. J., On assimilatory inhibition in plants, *Journ. Linn. Soc. Bot.* 31 (1896) 401.

TABLE 12.—*Temperature coefficients of photosynthesis, having the order of photochemical coefficients.*

Range of temperature—		Coefficient.	Investigator.	Plant studied.
Studied.	In which photochemical coefficients are valid.			
°C.	°C.			
−6 to +40.5	+3 to 38.3	1.0+	Matthaei	Cherry laurel.
+7 to 21	13 to 21	1.35	Blackman and Smith	*Elodea.*
24 to 45	24 to 40	1.26	Van Amstel	Do.
2.3 to 46.4	11.3 to 25	1.16	Kreusler	*Rubus fruticosus.*
9.5 to 39	9.5 to 39	1.0+?	Prjanischnikow	*Typha latifolia.*

The coefficients that we have obtained for photosynthesis are much smaller than those for most biological phenomena, since the latter, at similar temperatures, have coefficients of the magnitude required by the van't Hoff principle. These coefficients have been so thoroughly discussed that we need not consider them here. For literature on this subject, see the introduction.

Much of the literature, including many of the minor papers on the relation of temperature to photosynthesis, is not available in Manila. Therefore, a discussion of all of the literature on the subject is impracticable and will not be attempted. The work here considered includes that usually quoted as showing the relation between temperature and the rate of carbon dioxide assimilation. The literature has been discussed in detail by Matthaei and others. Such of it as is available is of no interest in the present discussion, and the references at our disposal indicate that this is true of the remainder.

The results of our analysis of the work discussed are remarkably consistent and seem to warrant the following conclusions:

CONCLUSIONS

The results of the work on carbon dioxide assimilation, here discussed, show temperature coefficients of from 1.00 and 1.40 over long ranges of temperatures which are favorable for this process. They are much smaller than those for most vital phenomena, which at similar temperatures are generally held to be of the order of magnitude required by the van't Hoff principle.

These coefficients are of the same order of magnitude as photochemical coefficients, which is not surprising in view of the fact that carbon dioxide assimilation is effected by light.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Curves, showing the relation of carbon dioxide assimilation and temperature at unit light intensity.
2. Curve, showing the results of Matthaei with four units of light.
3. Curve, showing the relation of light intensity and carbon dioxide assimilation in cherry laurel.

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THE ORIGIN AND DISPERSAL OF COCOS NUCIFERA

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Having had the opportunity of meeting Mr. J. F. Rock shortly after his trip to the Palmyra Islands I became much interested in his account of the exceptional conditions which he found in the flora of this small and isolated group. This flora proves, at least as far as the phanerogams are concerned, to be composed of an extraordinarily small number of species, belonging to the common strand flora of the Malay Archipelago and Polynesia, and of the coconut palm, which composes nearly the whole of the forests that cover these islands.

The Palmyra Islands belong to the category of those uninhabited coral islands, covered with dense groves of coconut palms, and of which Simmonds writes, as reported by O. F. Cook,[1] "the ungathered nuts which have fallen year after year, lie upon the ground in incredible quantities."

The special circumstances in which the Palmyra Islands are placed; their coral origin; their isolation, consequent to the great distance from any other land; the complete absence of indigenous inhabitants; the want of drinking water; the absence of any traces of economic plants that might suggest that they had ever been inhabited; and the certainty that they are but seldom visited either by fishermen or by any person who has tried to turn their wealth (which consists of the coconut solely) into a source of profit—all these give me the occasion, in addition to describing the peculiar characteristics of the coconut produced in these islands,[2] to offer certain considerations of an evolutionary and geographic nature, opposed to those which Mr. O. F. Cook has advanced with much competence and erudition in his two memoirs on the coconut palm.[3] Cook, in effect, sustains

[1] History of the coconut palm in America, *Contr. U. S. Nat. Herb.* 14 (1910) 298.

[2] *Cocos nucifera* Linn. forma *palmyrensis* Becc. in Rock, J. F., Palmyra Island with a description of its flora, *College of Hawaii Bull.* 4 (1916) 1–53, *t. 1–20.*

[3] The origin and distribution of the cocoa palm, *Contr. U. S. Nat. Herb.* 7 (1901) 257–293; and History of the coconut palm in America, *ibid.* 14 (1910) 271–342. The first of these memoirs will be denoted by "I" in this article; the second, by "II."

three principal theses, with which I entirely disagree. They are:

1. That *Cocos nucifera* must have assumed its actual specific characters upon the American continent, where it was found by Polynesian navigators, who later diffused it among their own islands, from whence it passed at a still later date into the Malay Archipelago and to the continent of Asia.

2. That *Cocos nucifera* in Asia, Malaya, and Polynesia, as in all other places where it is now found, can in no wise dispense with man's assistance and protection, without which it is incapable of maintaining its existence on the sea coasts.

3. That the ocean currents *cannot* have been efficacious means of its diffusion or be responsible for its wide distribution.

I have been the more induced to write these criticisms of Mr. Cook's assertions because this opinion of the American origin of the coconut palm appears to have found favor with several scientific authorities, among them Hugo de Vries[4] and Geoffrey Smith.[5]

IS THE COCONUT PALM OF SOUTH AMERICAN ORIGIN?

According to the thesis so ably and fully sustained by Cook, *Cocos nucifera* cannot be of Asiatic, Polynesian, or Malayan origin, but must be "a native of South America and carried westward across the Pacific in prehistoric times;" and its "original home must be sought in some sheltered valley of the Equatorial Andes."

The old argument—and it was a very good one for holding *Cocos nucifera* to be of American origin—namely, that all the other members of the *Cocoineae* (except *Elaeis guineensis*) are American,[6] has no longer any great weight, in view of the exceptions that recent botanical discoveries have made known.

In fact, the existence of a distinct species of *Elaeis* in Madagascar, different from *E. guineensis*, *E. madagascariensis* Beccari,[7] and the discovery of another true *Cocoinea*, *Jubaeopsis*

[4] Species and Varieties, etc., ed. 2, p. 82.

[5] The Cambridge Natural History 4 (1909) Crustacea 173.

[6] The presence in Madagascar of a species of *Elaeis* distinct from *E. guineensis*, almost induces me to suspect that the genus *Elaeis* should be regarded as being really African, and that instead of a representative having been carried from America to Africa, precisely the contrary occurred, and that the American *Elaeis melanococca* must be considered to be of African origin.

[7] Beccari, Palma del Madagascar 55, *f. 46;* Contributo alla conoscenza della Palma a olio (1914) 72, *t. 18.*

caffra Beccari,[8] in South Africa, must weaken the belief in a necessarily American origin of all the *Cocoineae.*

Indeed, *Jubaeopsis caffra* turns out to have many more affinities with *Cocos nucifera* than has any other palm whatever among those hitherto referred by authors to the genus *Cocos.*[9]

I have already shown elsewhere that *Cocos nucifera* is a monotypic palm, with but few affinities with the other palms included in the genus *Cocos,*[10] whereas it has much in common with *Jubaeopsis;* namely, the general conformation of the fruit; the ample central cavity of the seed; and the male flowers with sepals entirely free and imbricated. This affinity to *Jubaeopsis* had led me to hazard a doubt as to whether *Cocos nucifera* may have originated, not in Polynesia or in some lands which have now disappeared from that part of the Pacific as I formerly supposed,[11] but rather in the islands lying in the eastern Indian Ocean or in some other lands or islands, existing in former times between Africa and India.[12] According to this hypothesis, Ceylon and the Keeling Islands must lie almost in the region where *Cocos nucifera* assumed its present specific characters. The species of *Eugeissonia,* belonging to a genus of palms peculiar to the Malay region, which until now have been referred to the *Lepidocaryeae,* I have shown to have more affinity with the *Cocoineae* than with the *Lepidocaryeae.*[13] In the face of these

[8] Webbia 4: 169.

[9] After further careful study, I think it better to regard as distinct genera the subgenera *Arecastrum, Butia,* and *Glaziova,* proposed by me in Malpighia 5 (1888) 343. (Le Palme incluse nel genere *Cocos*). The genus *Arecastrum* is composed only of *C. Romanzoffiana* Cham., with its numerous varieties or subspecies and of the hardly specifically distinct *C. botryophora* Mart. To the genus *Butia* belong *C. capitata* Mart., and its numerous forms known by the names of *C. odorata* Barb.-Rodr., *C. pulposa* Barb.-Rodr., *C. lejospatha* Barb.-Rodr., and several others cultivated in our gardens under the names of *C. australis, C. campestris,* etc. The following are species of *Butia* also: *C. Yatay* Mart., *C. paraguaensis* Barb.-Rodr. (probably only a variety of *C. Yatay*), *C. eriospatha* Mart. ex Drude, and probably *C. stolonifera* Barb.-Rodr. Species of *Glaziova* are: *C. Weddelliana* Wendl., *C. coronata* Mart., *C. comosa* Mart., *C. petraea* Mart., *C. campestris* Mart., *C. flexuosa* Mart., and numerous other species described by Drude in the Flora Brasiliensis and by Barbosa-Rodriguez in his Sertum palmarum. On the whole the species of *Glaziova* amount to more than forty. *Cocos schizophylla* Mart. is *Aricuriroba Capanemae* Barb.-Rodr. (*Aricuri schizophylla* Becc.).

[10] Ann. Bot. Gard. Buitenz. Suppl. 3 (1910) 795.

[11] Op. cit. 802.

[12] Webbia, l. c.

[13] Webbia 4: 190.

facts the American origin of all the *Cocoineae* can no longer be considered as absolutely proved.

THE ASSOCIATION OF BIRGUS LATRO WITH THE COCONUT PALM

Birgus latro, the huge robber crab which is widely disseminated throughout Asiatic archipelagoes and Polynesia, is found also in the Palmyra Islands, and from Mr. Rock's account it abounds in that group along with other crustaceans. I have already made use of the association of *Birgus* with the coconut palm,[14] as an argument against the suggested American origin of *Cocos nucifera;* for it seems to me to be inadmissible that *Birgus* could have been specifically evolved independently of the coconut. Without coconuts it would have nothing to live upon; whereas, if this association did not exist, the peculiar and special formation of this crab's prehensile organs—thanks to which it is able to grasp and break open the coconuts, which are its only means of subsistence, to say nothing of its climbing the trees which bear them—would surely not have come into existence. In any case, it seems to me that this association can hardly have originated in those eastern valleys of Peru wherein Cook insists that *Cocos nucifera* had its origin. It is also a noteworthy fact that *Birgus* is found in association with the coconut palm even in places far distant from each other and to which this palm might be held to have spread in a natural way, such as the Keeling Islands in the Indian Ocean and the Palmyra group in the Pacific.

I do not know if *Birgus* has been found in the Cocos Islands, in the Pacific, where however I should not be surprised if it existed; because, although the adult *Birgus* is a creature adapted to a terrestrial life, in the larval, or "zoaea," state it has a pelagic existence and, therefore, can be carried enormous distances. Nevertheless, *Birgus* seems to be absolutely unknown on the American shores of the Pacific. This gives me the opportunity to suggest the hypothesis that the long-enduring biological connection between *Birgus* and the coconut palm, which in the course of time has had the power of modifying certain organs in *Birgus,* likewise, has had the same influence in causing the coconut palm to assume some peculiar features. I allude to the extraordinary thickening of the pericarp, which from a teleological point of view has been attributed either to the advantage it gives to the fruit when floating, by which its dispersal is favored, or to the importance of deadening the shock when it falls from the tree. This second opinion is also shared by

[14] Ann. Bot. Gard. Buitenz. Suppl. 3 (1910) 804.

Hugo de Vries in the work above cited. My idea is that this great development of the pericarp may be attributed to the effect of the stimulus given by the crabs during the plasmatic period to the pericarp of the young fruits, by their efforts to reach the seed, which may have caused an hypertrophy of the tissues of the pericarp itself, leading to the production of a fibrous, corklike tissue of a protective nature, such as is the bark of a tree. In consequence and by the light nature of this tissue, the fruit is made capable of floating independently of any final cause; thus some among the many fruits produced became very light, and for this cause alone their dispersal was favored in preference to that of the heavy fruits. All this, however, rests on the supposition that *Birgus* really is in the habit of climbing the coconut palm and that it does so to get at the immature fruits. In this connection I may observe that when in the Moluccas I often found imperfectly matured coconuts on the ground, which were more or less gnawed and entirely emptied of their kernels. This the natives assured me was the work of *Birgus latro.*

On the other hand Guppy [15] writes that he never saw *Birgus* unhusk the coconuts given to them for food when kept in captivity, but that to keep them alive it was necessary that the nuts should be opened for them. Hence it is not perfectly certain that *Birgus* succeeds in unhusking the coconuts when these are quite ripe and have fallen in the natural course to the ground.[16]

It seems to me that if the nut were not free from the husk, at least partly, it would be very difficult for *Birgus* to get at the kernel of a ripe coconut in a dry state through the dense stratum of the fibrous cork-like tissue of the mesocarp; whereas, it could easily do so in a young immature fruit. This would explain why *Birgus* is forced to climb the trees to provide itself with fresh nuts; whereas, it might make use of the fallen fruits, if it could open them.

However, it is easy to suppose that *Birgus* may make use even of the fallen fruits by attacking those that are beginning to

[15] Guppy, H. B., The Solomon Islands, 320.

[16] The botanist who accompanied Judge Cooper on his first expedition to Palmyra Island would remark here that he has personally observed *Birgus latro* unhusking coconuts. He more than once watched it in its laborious work, tearing fiber after fiber from the nuts found on the ground. He has also found the nests of *Birgus* filled several inches thick and covering many square feet of ground with the fibers of the coconut, each fiber single. He has not observed *Birgus* climbing the trees, but on board ship a *Birgus* climbed to the top of a 100-foot mast.—J. F. Rock.

germinate; for in such cases it is possible that it might succeed in reaching the albumen by gnawing at the young sprout with its mandibles.

DID THE COCONUT PALM EXIST IN AMERICA BEFORE THE DISCOVERY OF THAT CONTINENT BY CHRISTOPHER COLUMBUS?

Admitting that the coconut palm did exist in America on the Pacific coast before the discovery of the continent by Europeans, the data, on which Cook formed his opinion that from there it was disseminated on the Atlantic side, are so few and uncertain, that they offer little that can convince one of the correctness of his thesis. On the other hand, I cannot but wonder why the first sailors who reached that continent have not even mentioned the coconut palm, if for no other reason than because of the refreshing milk its fruit contains; whereas, there is not a sailor in the East who does not speak of the natives bringing coconuts to strangers to quench their thirst. Amerigo Vespucci, in his voyages—and he was the first who sailed along the whole length of the tropical east coast of America to the Gulf of Mexico and the Antilles—does not once tell us that the natives offered him anything of the kind. This appears very strange, since in Asia and in the Malayan islands coconuts are almost the first things offered by the natives to all new comers. I have no difficulty in admitting that Polynesians, Malayans, or Papuans may have reached and established themselves on the Pacific shore of tropical America,[17] and that they may have

[17] The belief, widely accredited, that natives of Asiatic, Polynesian, or Papuan origin exist on the western coasts of Central America would appear to be confirmed also by what Amerigo Vespucci writes in the account of his first voyage [Libro de viaggi di Amerigo Vespucci, di Stanislao Canovai: Firenze, Tipografia Tofani (1832)]. He relates that while sailing (as it would seem) along the coasts of the Caribbean Sea, in the neighborhood of the Isthmus of Panama, he landed on an island in that sea about 15 leagues from the mainland, in which he found the most brutish and hideous people he had ever seen; he says that these savages had their mouths so full of an herb which they continually chewed that they could hardly speak. Each wore at his neck two small dry gourds, one holding the herb they were chewing, the other containing a white powder, which looked like powdered gypsum; into this one they dipped from time to time a little stick of the shape of a spindle, previously moistened in their mouths, and therewith flavored the herb they chewed with the aforesaid powder. It seems indubitable to me that such a custom corresponds to that which generally prevails among the Malays and other Asiatic populations at this day, of chewing the leaf of the betel and other things together with powdered lime, for the last must have been the white powder of which Vespucci speaks.

carried thither the coconut palm together with the banana; but I positively cannot admit that they found the coconut palm on the American shores of the Pacific, carried it back with them, and disseminated it throughout Polynesia and tropical Asia.

The difficulty brought forward by Cook, that the coconut palm could not have been introduced into America by the Spaniards or by the Portuguese, because the fruits could not have preserved their germinative faculties during so long a voyage, has no force; because, Cook's assertion to the contrary, coconuts can withstand several months' dryness, especially if kept under the influence of sea air; moreover, they can germinate while hanging in the rigging of a ship. It is exceedingly common in the Malayan islands to see a bundle of coconuts sprouting while hanging to the posts of a hut.

With respect to the origin of *Cocos nucifera* and its supposed native land among the salt-bearing regions of eastern Peru, Cook concludes by saying (II, p. 307):

> "It would be reasonable to turn to these saline districts of South America if any attempts were to be made to definitely ascertain the original home of the coconut by finding it in a truly wild state." Fortunately the author hastens to add: "Such a discovery is hardly to be expected, because of the probability that localities suited to the spontaneous growth of coconuts would have attracted human inhabitants, even in very early times."

But in that case will Mr. Cook tell us why he holds that in such localities *Cocos nucifera* could have constituted itself as a specific entity, have grown, and reproduced itself, without the assistance of man, but yet not have done so on the oceanic coral islands?

And again:

> We may hope, however, to find a series of local varieties or subspecies of the coconut palm in these interior localities, varieties that will be more hardy and vigorous than the maritime forms of the palm cultivated in the humid parts of the Tropics, and more likely to thrive under semi-tropical conditions.

Such a search can very well be carried out by some enterprising botanist; but, as a matter of fact, no one has met with such forms or varieties of *Cocos nucifera* in the regions mentioned. I do not claim, however, that such an event is absolutely improbable or that varieties and species of *Cocos* as yet unknown to botanists, possessing more affinity with *Cocos nucifera* than have any of the other *Cocoineae* known hitherto, may not be found in such localities; but such a find would be a less extraordinary thing than that the big fruits of the coconut palm should have crossed the Andes and thence have been dispersed among the islands of the Pacific.

DISSEMINATION OF THE COCONUT BY MARITIME AGENCY

Cook writes (I, p. 276) that the ocean currents are an effective agency for the dissemination of the coconut and that "the theory of the transfer of fruits by ocean currents has received much attention and far greater credence than the facts seem to warrant." "The poetic theory of the cocoanut palm dropping its fruit into the sea to float away to barren islands and prepare them for human habitation" is called a "time-honored fancy." (I, p. 276.) And again he says (II, p. 297): "A palm that is unable to maintain itself on the land has nothing to gain by having its nuts drifted about by the sea." It seems to me, however, that the restocking with plants of the islands in the Sunda Strait after the explosion in 1883 contradicts all these assertions, for both in Krakatau and in the small islands in its immediate vicinity that catastrophe involved the complete destruction of all organic life. This notwithstanding, Ernst [18] informs us that at the time of his visit to those islands, only a few years after the cataclysm, "the large number of coconut palms" was "an especially remarkable feature." In the earliest visits to the devastated islands, Doctor Treub and Professor Penzig not only picked up coconuts which had been thrown up on the beaches by the waves, but also, very soon encountered coconut palms pushing their young green fronds through the soil; and in Plate IV, fig. 7, of Ernst's book a young coconut palm at the upper edge of the tide level (southeast coast of Krakatau) can be seen; in Plate VIII, fig. 11, an entire group of coconut palms is seen "towering above the other trees;" and of this group our author writes:

> "To our great delight we found the coconut palms laden with fruit. The large number of ripe nuts on the ground, *several of which had germinated and produced plants reaching one meter in height*, showed that, they must have attained the fruiting stage some years ago: a renewal of the forest is thus amply provided for. We were all refreshed by a quantity of unripe fruits which one of our Javanese companions brought down from the crowns of the palm trees." The same author on disembarking at Zwarte Hoek, likewise in Krakatau, writes: "Young coconut palms occur here and there with seedlings of *Barringtonia speciosa*, etc.;" and on page 68: "Groups of strand-plants have penetrated inland for a distance of 300–500 m." and among these are coconut palms. He adds that young coconut palms and *Pandanus* clumps are so near the edge of the sea that their stems are washed by the waves at high tide.

Another observation by Cook seems to me unsustainable; namely, that (I, p. 276) "the cocoanut palm seldom grows upon

[18] Ernst, A., The New Flora of the Volcanic Island of Krakatau, 58.

the immediate strand overhanging the water, or even in reach of ordinary waves." But everyone acquainted with the coasts of Asia and of the islands of the Malayan Archipelago and Polynesia knows the contrary to be the case. Cook himself (II, facing p. 299, Plate 54, fig. 1) gives an instructive illustration of "Coconut palms overhanging the surf at high tide, Puerto Barrios, Guatemala," and another half-tone from a photograph (fig. 2) of "Coconut palms overhanging the sea, Livingston, Guatemala." Against these assertions of Cook's one may oppose Ferguson's words:[19]

> "The coconut tree flourishes better near the sea coast than in an inland situation. In such a vicinity it acquires more vigour, and produces with more fecundity; it never grows so luxuriant in the interior, where the air is not charged with saline particles, and salt water always seem to nourish it more than fresh water. The sea may wash the bottom of coconut trees without injury to them." And again, quoting Bertolacci, "It flourishes so very near the sea, that its roots are in many places washed by the waters without injury to the trees, until it is actually undermined."

As a result of my personal experience, also, all the arguments brought forward by Cook have not convinced me in the least that fruits of the coconut palm cannot be disseminated by the action of ocean currents, although he maintains (II, p. 324) that after his own observations no doubt can possibly remain that the contrary is the case. In fact he writes:

> "For nearly two centuries the coconut has been described in books of travel and natural history, and even in formal scientific works, as an example of a plant widely distributed in nature through the agency of ocean currents." The following are also his words (II, p. 300): "The possibility that a coconut might be stranded on a newly formed island and multiply in the unoccupied soil, according to the fable, may not be absolutely excluded, but we know that the monopoly would not be of long duration." This, because the writer holds that young plants would be suffocated by "their forest-forming competitors."

I would observe, however, that these competitors on the sea shore would be only halophilous plants, which have never shown themselves to be incompatible with *Cocos nucifera*, especially on the sea beaches of coral islands, which are always in immediate contact with the sea. If on many continental and insular coasts of Asia the coconut palm is not met with, I would give among other reasons, which I shall state later, this one, that it is just because forest plants from the interior have found the means of forestalling or supplanting the strand plants which originate from drift seeds.

[19] Ferguson, All About the Coconut Palm, 111.

The coconut palm (always according to Cook) "cannot be disseminated by ocean currents." He says that (I, p. 277) "it is far from correct to suppose that all nuts [of the coconut palm] which reach the water are really launched for oceanic wanderings; the chances are still hundreds to one that they will be thrown back immediately upon their own coast, like other objects floating in the surf. High waves or tides, instead of floating shore débris away, merely carry it farther inland, as everybody familiar with seacoasts knows."

That there may be some coasts the surf on which has greater power of carrying away material than of bringing it thither, I admit; but that, as a general rule, the sea does not throw back floating objects of various kinds, including the fruits and seeds of plants, is undeniable. How could all the strand floras of the world have been formed, if the sea did not carry their seeds to the beaches by means of its currents? Furthermore, suppose it were true that the surf does carry objects inland, would not that be a favorable circumstance for the dissemination of fruits which have fallen on other beaches bathed by the same sea, or into the sea itself?

THE COCONUT PALM DOES NOT ALWAYS STAND IN NEED OF THE ASSISTANCE OF MAN

Cook believes (I, p. 280) that "human assistance" is necessary to the introduction and maintenance of the coconut palm, and he says (II, p. 296) that this palm "is not known to exist except as a cultivated plant;" and (II, p. 297) that "we should find old palms surrounded by flourishing young ones growing spontaneously without the aid of man." And again, "There seems to be no authentic record of coco palms establishing and maintaining themselves on any tropical coast in a wild or truly spontaneous condition." He adds that: "The complete absence of coconuts from the extensive tropical coast line of Australia until planted by European colonists" is, "a gigantic experiment showing that the coconut did not establish itself without human help, even in a place where it afterwards thrived in cultivation." Cook (II, p. 299) also quotes Pickering[20] to the effect that "throughout the Pacific the coconut occurs only on those islands to which it has been carried by the natives." From another author[21] Cook quotes: "It is to be emphasized that all coconuts are planted; the idea of a wild palm being as strange in Funafuti as that of a wild peach in England * * * I doubt whether, despite popular opinion to the contrary, a wild coconut palm can be found throughout the breadth of the Pacific."

That the assistance of man is necessary to the coconut palm is indubitable whenever it is cultivated in districts wherein there are not combined all the conditions of climate, etc., which its nature as a halophilous plant demands, and wherein it

[20] Pickering C., Chronological History of Plants (1879) 428.
[21] Hedley, Australian Mus. Memoir 3 (1896) 22.

has to dispute the soil with other plants, or finds foes which injure its fruits when fallen to the ground or its young sprouting plants, or cause the death of the adult trees. But large groves of the coconut palm exist in a most flourishing condition in places where man most certainly does not contribute to their maintenance, and where they now produce themselves naturally, even supposing it were the case that the first fruits were deposited by man.

The Palmyra Islands are just such a case; there, as Darwin observed of the Keeling group, "the young and fully grown coconut trees grew intermingled with the adult plants."

It would appear that the same is the case on other coral islands of the Pacific; for examples, Palmerston Island and probably also Cocos Islands, formerly—that is, before they had been inhabited by Europeans. *Cocos nucifera* in these localities may be regarded as really wild and as a true representative of a strand flora; but admitting that the coconut palm, to establish itself on an oceanic island, has required, as a rule, the hand of man to carry its fruits thither, the case of the Palmyra Islands demonstrates that it is absolutely contrary to the truth to assert that the coconut palm can never flourish and reproduce itself spontaneously without the protection and help of man.

I cannot credit that even if the Polynesians did carry the coconut to the Palmyra Islands, they ever returned thither to take care of the plants. Yet the coconuts of the Palmyras are among the largest and finest known, and their albumen is more developed than that of most varieties cultivated by man. On oceanic islands, and especially on atolls, the coconut palm can establish itself; because when once the waves have deposited the fruits the young plants do not have to fear any competition with the primitive forest for the soil, and also because their competitors can at worst be only a few halophilous plants, produced from seeds brought thither at the same time as themselves, which can not oppose any great resistance to the growth of the coconut palm. Moreover, a most essential matter, no destructive marauders can have existed in such islands; while, on account of their great isolation, not even the foes of the coconut tree that are most to be dreaded—the red and the black bettles—have been able to reach them. Still arguing to sustain his theory, Cook writes (II, p. 303): "Unless the human friends of the young coconut are at hand to keep down the other vegetation the period of infancy is not survived." But it must be observed that the special conditions, required for the coconut palm to develop and reproduce itself indepedently of man, are just those found either

on newly emergent beaches, such as those of Krakatau, or on the oceanic islands on which grow only a few species of plants born from drift fruits, and on which there exists no animal likely to be hurtful.

But if one holds as correct Cook's assertion, that *Cocos nucifera* cannot have developed its actual qualities without man's protection except in America, we must admit that the cradle of mankind was America; for Cook is right when he says "that the useful cultivated plants offer the best record of man's primitive existence." If this *Cocos* cannot live without man's protection and if man must necessarily have been its distributor, we must also admit, either that man was the creator of the species *Cocos nucifera*, or that man appeared on earth at least contemporaneously with *Cocos nucifera*. The fact that the coconut palm has not established itself in Australia without help, although its nuts must certainly have been carried to its shores, can be understood when we consider that Australia is one of those regions where the conditions are precisely such that the coconut could not establish itself without man's assistance; such conditions are the predominant vegetation; the too great dryness, especially during the period of germination; and the presence of animals destructive to nuts and to young and to full-grown plants.

Cook finds another argument for maintaining that the coconut palm cannot have disseminated itself in the asserted fact that its fruits, falling from such a height, must surely be injured by the cracking of the kernel, which would have the effect of reducing "materially the chances of successful germination." But even if this were true (and in the case of some very tall palms it may perhaps happen), this must also have been the case in the birthplace of the coconut palm where there was no man ready, as he says, "to let the fruits down carefully to avoid injury" to them. Setting aside the small probability of such peril, it must be remembered that the coconut palm begins to fructify when only a few meters high; therefore, there is no danger whatever that its fruits will be injured by their fall or that there will not remain a sufficient number of them to secure the reproduction of the species.

THE CORAL ISLANDS ARE THE LOCALITY BEST ADAPTED TO THE SPONTANEOUS REPRODUCTION OF THE COCONUT PALM

The manner in which the volcanic island of Krakatau (whence every slightest trace of vegetation was swept away by the explosion) has been restocked with plants, under our eyes, reveals the manner by which the coral islands can have been populated

with a new flora, as soon as they were in a condition to sustain a vegetation.

The transportation of seeds of plants to these coral islands may have been effected otherwise than by the usual ocean currents, by means of extraordinarily violent storms, by exceptionally high tides, and by the great waves that are occasionally produced by telluric movements, and which are of no rare occurrence in that part of the Pacific, wherein a good number of the islands appear to rest on volcanic bases.

It does not seem likely that other forces, such as the winds, or birds, or other fruit-eating animals, have contributed much to populate certain coral islands (the Palmyras amongst others) with flowering plants; because the seeds that might have been carried to them by these means belong almost wholly to species that do not tolerate the presence of salt in the soil and often not even in the air.

The oceanic coral islands of new formation can be populated only by plants of which the seeds, besides being able to float, possess also outer wrappings of such a nature that they can resist the action of salt water, and which, moreover, can tolerate the presence of salt during the period of germination; thus is explained the scanty number of plants found on oceanic islands, which, like the Keelings and the Palmyras, cannot be regarded as being the relics of ancient drowned lands.

The Palmyra Islands belong in fact, like the Keelings, to those islands constituted entirely of coral, of which Darwin wrote, as quoted by Hemsley,[22] that they "at one time, must have existed as mere water-washed reefs," and to which all the terrestrial products that existed on them, before Europeans settled on them and even before any natives had reached them, "must have been transported by the waves of the sea."

It is precisely on account of this circumstance that I maintain that the coconut palm has been able to establish itself, unaided by man, both in the Palmyras and in the Keelings and, probably, in other islands, not well known to us. Indeed, it is on islands of this kind and on their scanty soil, almost level with the water, that any coconut which may have been washed up on the beach and been able to germinate, finding no hindrances nor obstacles in any preëxisting forest vegetation, would have been able to grow and prosper, because it did not find there the many enemies which would have hindered its independent development on the shores of a continent or on one of the great Asiatic islands.

[22] Report of the Voyage of H. M. S. Challenger, Bot. 1 (1885), The South-Eastern Moluccas, 114.

Among the most dreaded foes of *Cocos nucifera*, the wild hogs must be reckoned. With respect to these we read in Ferguson [23] an extract from the Ceylon Examiner, as follows:

> Amongst the enemies of the coconut tree the wild pig has the first place. Not only because he is the most destructive to young plantations, I suppose, but because he is about the earliest enemy that the plant has to contend against.

It is certain that on the coasts of Asia and on the shores of the Malayan and Papuan islands, where the wild pig is excessively abundant, not a single coconut would succeed in producing an adult plant without the protection of man, even though all the other conditions were favorable. There are besides the pigs other mammals such as certain rodents and herbivorous marsupials, which are very injurious to the coconut; among the last I learn that in New Guinea the "little flying opossum" (*Belidens ariel*) is in the habit of completely emptying the ripe nuts. It is noteworthy, also, that whole plantations of coconut palms can be utterly ruined by the injury caused to the adult plant by two very dangerous insects, the red beetle (*Rhynchophorus ferrugineus*) and the black beetle (*Oryctes rhinoceros*). [24]

That the coconut palm not only can exist, but can prosper without man's help and can even produce finer and larger fruits than in places where it is carefully cultivated, is clearly evidenced by the dimensions of the coconuts of the Palmyras which I have already described. This fact may be attributed to the very special conditions inherent in the soil of the Palmyras; for though at first sight one would be inclined to think that *Cocos nucifera*, which is so exacting a plant as to fertilizing elements, could draw very little aliment from a soil composed solely of disintegrated coralline rock, of which rock the islands are formed, it does in fact find abundant nutrition therein.

The fact is that in coral islands, in addition to the detritus of various kinds, all capable of being transformed into humus, which the sea may have brought to them, the soil which forms upon them may contain fertilizing substances due to the remains of animals that have contributed to the formation of the reef;

[23] All about the Coconut, 137.

[24] How the presence of an insect can impede the acclimatization of a plant in a new region, the following fact demonstrates. For several years I cultivated *Aubrietia deltoidea*, a pretty *Cruciferae*, native to southern Italy, but unknown in Tuscany, which maintained and multiplied itself upon a rockery without any help, in my garden near Florence; until it was attacked one spring by the larva of a small beetle, *Ademonia tanaceti*, which devoured it to its last leaf, since which it has never reappeared.

to the accumulation of guano deposited by sea birds; and finally to the remains of the innumerable mollusks and crustaceans by which coral islands are usually populated.

THE COCONUT PALM A HALOPHILOUS PLANT PECULIARLY ADAPTED TO TROPICAL SEA COASTS AND TO OCEANIC DISPERSAL

A chemical analysis of the ashes of the coconut palm shows that all its organs contain chloride of sodium in considerable quantity; this salt, indeed, after the salts of potassium and of lime and the phosphates, being their most abundant constituent; it is even more abundant than silica, which in the state of crystals is found to be especially abundant in the leaves.

According to the summing up of Prudhomme,[25] a plantation of 1 hectare of the coconut palm annually draws out of the soil 120 kilograms of marine salt. And from Ferguson's report [26] we learn that an adult plant requires each year 1.34 kilograms of chloride of sodium. Salt, therefore, is considered an important manure for the coconut palm—far more than the quantity found in its ashes appears to demonstrate.

From the same source I learn that Doctor Gardner, to show the value that the Brasilians attribute to salt as a fertilizer for coconuts, states that "a man would walk many miles for it, pay high for a load, and then apply it to a single tree." Elsewhere, it is stated that sea weeds and the ashes of plants that contain much salt are used as manures for the coconut palm. Ferguson also states (p. 142) that the Singhalese "invariably throw a little salt into the holes before they place the coconut plants in them." And on page 111, speaking of a new plantation of coconuts which is being made inland and at a distance from the sea, he says: "it is customary to throw a considerable quantity, as much as half a bushel, of salt into the hole which receives the coconuts."

Prudhomme, [27] writing of the toleration of the coconut palm for marine salt, asks if marine salt should not be reckoned among the fertilizers to be administered to this palm, as it seemed to him, that instead of merely tolerating it, the coconut had a real preference for this salt. The excessive toxicity of sodium chloride for plants is well known; the coconut palm, however, is one of the few that can live on a salt soil. For that reason I am not able to understand how a plant endowed with

[25] Le Cocotier, 262.
[26] Op. cit. 66.
[27] Le Cocotier, 40.

such high hereditary halophitism—which, therefore, not only tolerates, but actually prefers, a salt soil and, moreover bears fruit so constituted as to be, as Seeman writes,[28] "often tossed about the ocean for months without losing its germinating power from the effects of salt water"—can have been plasmed or brought into existence in a region remote from the sea.

That *Cocos nucifera* is a true halophyte, that is to say, a plant capable of resisting the physiological action of mediums rich in chloride of sodium and in the other salts that are characteristic of sea water, the very presence of which is pernicious to most other types of vegetation, shows that it must have been placed in close contact with salt soils during the period of its evolution; considering, therefore, all the other circumstances that may have been required during and for the evolution and plasmation of the species *Cocos nucifera,* we are led to conclude that it must have originated on maritime shores.

Few are the true halophytes, and for this reason the flora of maritime shores and of the coral islands is poor in species, but in compensation they are of extremely wide geographic distribution. And this is because there are few plants having seeds tolerant of salt and at the same time provided with fruits capable of floating and of enduring a long immersion in salt water and, hence, fitted for long voyages. The coconut palm is one of these few. It is true that this palm can grow and even prosper far from the sea and can exist at a certain elevation above it, but it is probable that in these localities it can always find the quantity of chloride of sodium it needs. But although it is true that the coconut palm is capable of adapting itself to non-saline soils, as other halophilous plants can do, it none the less remains true that if *Cocos nucifera* were not a plant of the sea shore, and therefore an indubitable hereditary halophyte, it would not be better suited by a soil rich in chloride of sodium than by a soil devoid of that salt. It was therefore on the shores of the sea and especially on those of the coral islands that *Cocos nucifera* must have found the conditions under which it assumed its present specific characters; because there it would have had little to fear from the competition of other large plants of the strand flora and because there, also, it had not to struggle against powerful foes. Therefore, it cannot be admitted that the coconut palm is "unable to maintain itself on the sea coasts," and "the popular idea" that the "coconut palm is a plant specially adapted to tropical sea coasts" is, and remains, a true idea.

[28] Fl. Vit. 276.

CONCLUSIONS

From the preceding study, which was chiefly suggested to me by the conditions in which the Palmyra Islands were found by their explorers, Messrs. H. E. Cooper and J. F. Rock, I conclude:

1. That the coconut palm may have been very easily disseminated by the agency of oceanic currents.

2. That the coconut palm is a halophilous plant with a predilection for the sea shore.

3. That an Asiatic or Polynesian origin of the coconut palm is more probable than an American one.

4. That the coconut palm can occasionally exist and reproduce itself in the tropics indepedently of man, and that the latter's protection is necessary to it only when it occurs in regions wherein its existence is disputed by the nature of the soil, by other preëxisting vegetation, or by foes of various kinds.

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NEW SPECIES AND A NEW GENUS OF BORNEO FERNS, CHIEFLY FROM THE KINABALU COLLECTIONS OF MRS. CLEMENS AND MR. TOPPING

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TRICHOMANES Linnaeus

TRICHOMANES BROOKSII sp. nov.

Gonocormus; rhizomate filiforme late repente nigro, pilis castaneis minutissimis vestito; stipite 5 ad 20 mm alto, filiforme, erecto, fere nigro, nudo vel sparsissime pubescente, haud alato; fronde usque ad 4 cm alta et 25 mm lata, pseudotripinnatifida, rhachi alata; segmentis infimis fere oppositis ca. 2 cm longis maximis, adscendentibus, parte mediale sympodiale, pseudopinnatifida vel -bipinnatifida; segmentis ultimis obtusis vel acutis, univerviis, venulis falsis carentibus; indusio profunde campanulato, late alato indeque in apice segmenti dilatati immerso, ore patente vix bilabiato, receptaculo exserto.

Sarawak, Mount Bongo, *Brooks and Hewitt*, 1908.

By the description, this appears to be near to *Trichomanes Hosei* Baker, of Mount Matang, which, however, seems to be typically pinnate in plan, with much more narrowly winged and rather two-lipped involucres. Above the forking of the veins of *Trichomanes Brooksii*, they are connected for a notable distance by the lamina, which thus becomes conspicuously widened at these points.

HYMENOPHYLLUM Smith

HYMENOPHYLLUM FOXWORTHYI sp. nov.

Euhymenophyllum H. blumeano affine, involucro fere omnino immerso; rhizomate filiforme, late repente, sparse fusco-piloso; stipite ca. 3 cm alto, filiforme, ad apicem ipsum plerumque anguste alato; fronde 5 ad 8 cm alta, 12 ad 20 mm lata, utrinque angustata, primo sparse pilosa, mox glabrescente, olivacea, fuscescente, rhachi anguste alata; "pinnis" pinnatifidis, "pinnulis" paucis, maximis furcatis, segmentis integris, 1 mm latis, planis, acutis obtusis vel marginatis, costis applanatis, parietibus cellularum crassis, pariete marginale segmenti valde incrassata,

uniforme (haud intus crenulata), cellulis marginalibus et costas secus opacis; soris segmenta prima acroscopica terminantibus, involucro anguste obconico immerso, limbo bilabiato libero brevissimo, late rotundato, subintegro, receptaculo clavato, breviter exserto.

Sarawak, Mount Santubong, *Foxworthy 458*, June, 1908.

Clearly distinguished by the opaque margin and *Trichomanes*-like sorus. The former is distinct in character from that of *Crepidomanes*; and in spite of the latter, I believe there is no doubt as to the affinity and proper classification of the plant.

HYMENOPHYLLUM CLEMENSIAE sp. nov.

Euhymenophyllum minutum pilosum; rhizomate filiforme glabrescente; stipitibus usque ad 1 cm longis, aut alatis usque ad pedes, aut fere omnino exalatis; fronde usque ad 3 cm alta, 1.5 cm lata, utrinque angustata, fuscescente, ad alam latam pinnatifida; segmentis obtusis pinnatifide vel dichotome incisis, segmentis ultimis integris, oblongis, obtusis, 0.7 mm latis, costis pilosis, pilis fuscis, simplicibus, subdeciduis, cellulis laminae minutis, uniformibus; soris ad vel ultra medium indusium immersis, parte immersa dense sed subdecidue pilosa non carinata, labiis liberis semiorbicularibus glabris, receptaculo clavato incluso vel breviter exserto.

Mount Kinabalu, Gurulau Spur, *Mrs. Clemens 10780* (type), *Topping 1619*; Kiau, *Mrs. Clemens 10226*.

Clearly distinguished in its subgenus by the long, simple hairs on the veins, particularly dense hairiness of the lower part of the involucre, and glabrous lips. The color and pubescence place it in the group of *Euhymenophyllum* which approaches *Leptocionium*.

HYMENOPHYLLUM HOSEI sp. nov.

Leptocionium lamina plana, rhachi late alata; rhizomate crasso-filiforme, glabrescente, laete fusco; stipite 10 ad 17 mm alto, fere ad basin alato; fronde 4 ad 5 cm alta, 2 ad 3 cm lata, ovata, bi-tri-pinnatifida, rhachi nigro-fusca, ubique late alata ala denticulis sparsis ornata; pinnis inframedialibus majoribus, ad alam rhachidium ipsarum pinnatifidis, pinnulis superioribus simplicibus, inferioribus furcatis vel rarius pinnatifidis cum 3 ad 5 segmentis; segmentis 2 ad 3 mm longis, 0.8 mm latis, obtusis, ubique anguste denticulatis, marginibus et dentibus nigrescentibus, lamina alibi fuscescente; soris in segmenta prima acroscopica pinnarum superiorium insertis, parte inferiore obconica immersa, receptaculo crasso-setiforme, labiis fere aequilongo, involucro extus deorsum denticulato vel aspero vel fere nudo, ca. ad medium fisso, labiis ovatis inconspicue dentatis.

Sarawak, Mount Trekan, altitude 600 meters, *Hose 730*, 1894–95.

Distinguished from otherwise similar species by the broad, flat wing of the rachis. The blackish margin is occasionally found in other species and may not be a constant character.

HYMENOPHYLLUM PERFISSUM sp. nov.

Leptocionium lamina plana, involucro fere ad basin fisso labiis integris; rhizomate filiforme, fusco-nigro, ramoso, nudo; stipite 10 ad 15 mm alto, glabro, filiforme; fronde ca. 4 cm alta, 10 ad 15 mm lata, glabra, pinnata, rhachi sursum anguste alata ala integra, deorsum vix marginata; pinnis majoribus subpinnatifidis segmentis 3 ad 5, minoribus furcatis, minimis simplicibus, segmentis ca. 4 mm longis, vix 1.5 mm latis, obtusis, serratis dentibus paucis subspiniformibus, fuscis vel fusco-olivaceis; soris segmenta abbreviata prima acroscopica pinnarum subapicalium occupantibus, receptaculo fusiforme incluso, involucro $\frac{5}{6}$ ad basin fisso, labiis obovato-orbicularibus, integris, nudis, 1.5 mm longis.

Mount Kinabalu, altitude 3,700 meters, on tree trunks, *Mrs. Clemens 10588*.

Apparently a quite distinct little plant.

PTERIS Linnaeus

PTERIS CLEMENSIAE sp. nov.

Species gregis P. quadriauritae sensu latiss., pinnis infimis non furcatis; stipitibus 30 ad 50 cm altis, fuscis, ad basin paleis castaneis vestitis, alibi sub lente minute punctulatis; fronde ca. 45 cm alta, 40 cm lata, pinnata, parte apicale 25 cm longa; pinnis 2- vel 3-paribus, infimis paullo maximis, petiolulis ca. 1 cm longis, lanceolatis, ca. 25 cm longis, 7.5 cm latis, in caudam angustissimam fere 4 cm longam terminantibus, ad alam 0.2 ad 0.4 mm latam pectinatis; costa inferne straminea prominente, superne angustissime bialata, alis ad insertionem costulae quaeque in spinulam excurrentibus; segmentis usque ad 4 cm longis, 5 ad 6 mm latis, supra mediam 2 ad 3 mm distantibus, obtusis vel minute et obscure mucronulatis, venis utroque latere usque ad 24 prope costulam furcatis et 6 simplicibus; indusio griseo, 0.6 mm lato, fere ad sinum et apicem attingente.

Mount Kinabalu, near Lobang, *Mrs. Clemens 10348* (type), *Topping 1602*.

PTERIS TOPPINGII sp. nov.

Stipite 40 cm alto, glabro, stramineo-viride; fronde 30 cm alta, parte apicale 20 cm alta, 7 cm lata; pinnis utroque latere 2 vel 3, infimis brevipedicellatis (petiolulis 2 mm longis), sequentibus sessilibus, infimis ca. 20 cm longis, in segmenta 3 ad 4 cm longa, 8 mm lata terminantibus, ad alam fere 1 mm latam pinnatifidis;

costa inferne prominente fusca, superne canaliculata, non spinifera; segmentis ubique contiguis vel imbricatis, 3 ad 4 cm longis, 1 cm latis, apice late rotundatis, integris, atroviridibus; venis utroque latere ca. 14 fere ad costulam furcatis et 3 simplicibus, omnibus inconspicuis; indusio angusto (0.6 mm lato), soro aperto ultra 1 mm lato.

Mount Kinabalu, Khota Balud to Kibayo, *Topping 1488*.
A species clearly distinguished by its broad and close segments.

PTERIS PURPUREORHACHIS sp. nov.

Species gregis P. longipinnulae, stipite rhachique atropurpureis; stipite 30 ad 40 cm alto, basi paleis parvis pallidioribus praedito, sursum glabro, nitido; fronde 40 cm alta, deltoidea, parte apicale 20 cm alta; pinnis utroque latere 3- vel 4-paribus, stipitulatis sed petiolulis alatis, infimis furcatis, 20 ad 25 cm longis, acuminatis, ad alam 3 ad 4 mm latam pinnatifidis; costa superne subbialata, spinulis ad insertiones costularum appressis; segmentis fertilibus 7 ad 8 mm, sterilibus usque ad 1 cm latis, 3 vel 3.5 ad 5 cm longis, obtusis vel acutis, inter se 2 ad 5 mm distantibus, apices versus serrulatis, membranaceis; venis infimis plerumque bifurcatis, aut liberis aut more P. biauritae anastomosantibus et areolam unam costalem includentibus, sequentibus furcatis vel rarius bifurcatis usque ad 14-paribus, simplicibus ca. 3; soro sinum interdum transeunte, apice remoto, indusio pallido, 0.8 ad 1.0 mm lato.

Mount Kinabalu, Lobang, *Mrs. Clemens 10350* (type), *Topping 1790*.

HUMATA Cavanilles

HUMATA KINABALUENSIS sp. nov.

Euhumata, H. repenti et H. alpinae affinis, perfectius dimorpha et dentium carentibus; rhizomate generis typicale, paleis magnis persistentibus, marginibus earum pallidis; stipitibus frondium sterilium 2 ad 3 cm, frondium fertilium 4 ad 5 cm altis, sparse squamosis; fronde sterile ca. 6 cm alta, 5 cm lata vel minore, pinnata, rhachi valida, pinnis infimis ad costam complanatam pinnatisectis, segmento infimo basiscopico pinnatilobato, pinnis sequentibus incisis, segmentis oblongis vel obovatis, obscure serrulatis, obtusis, coriaceis, deorsum et inferne squamatis; fronde fertile aequale vel longiore, lamina valde angustata; soris magnis in lobos truncatos breves apicalibus, indusio quam alto latiore.

Mount Kinabalu, below Paka Cave, *Topping 1745*.
The sori are impressed on the fertile tooth, so as to produce swellings on the upper surface.

NEPHROLEPIS Smith

NEPHROLEPIS (?) MARGINALIS Copel. sp. nov.

Stipite 45 cm alto, badio, pilis brevibus vestito; fronde 70 cm alta haud deorsum angustata, pinnata, pinna apicale elongata, rhachi et praecipue deorsum costis minute velutinis; pinnis rectis, infimis 18 cm longis, 13 mm latis, brevi-stipitatis, obtusis, auriculis brevibus acroscopicis praeditis, crenulatis, papyraceis, glabris, superne nigris (in herbario), inferne atroviridibus; venis furcatis; soris marginalibus vel submarginalibus, contiguis; indusiis 0.8 mm latis, 0.4 mm altis, basibus adnatis late rotundatis, apicibus truncatis.

Mount Kinabalu, Gurulau Spur, *Topping 1632*.

The specimen is incomplete, being without caudex. By the characters of the sorus, the plant is a *Cystodium*, and I feel sure the affinity thus suggested is a real one. The phylogeny of *Nephrolepis* has never been cleared up, and I believe that this species furnishes the necessary clue to it, the line being *Dicksonia-Cystodium-Nephrolepis*. We have, therefore, to go back to *Dicksonia*, commonly treated as outside the *Polypodiaceae*, to find the common ancestor of *Nephrolepis*, of the *Balantium* series (*Saccoloma*), and the very extensive series of *Dennstaedtia* derivatives. To find an ancestor common to these ferns and the other *Polypodiaceae*, we must of course go still farther back. To establish natural families, we have therefore either to include *Cyatheaceae* and *Matoniaceae*, and perhaps still other of the recognized families. in the *Polypodiaceae*, or else to split *Polypodiaceae* into the several phylogetic series. If the latter alternative is tried, the resulting groups will defy definition.

CYATHEA Smith

CYATHEA CAPITATA sp. nov.

Caudice 3 m alto; stipite 25 cm alto, 1 cm crasso, deorsum nigro paleis stramineis 15 mm longis 3 mm latis valde acuminatis integris vestito, sursum sordide atropurpureo, glabrescente; fronde 1.5 ad 2 m longa, utrinque angustata, abrupte brevi-acuminata, rhachi purpureo-fusca, segmento apicale deltoideo, basi lobato; pinnis subsessilibus, basi aequaliter truncatis, apices serratos versus sensim angustatis, alibi integris, potius acuminatis quam caudatis, glabris, papyraceis, inframedialibus 18 cm longis, 3 cm latis, horizontalibus; venis conspicuis, 2- ad 4-furcatis, venulis soriferis plerumque super soros anastomosantibus; soris in lineam unam irregularem utroque latere costae et ca. 5 mm distante instructis; indusio laete fusco nitido, tenue sed persistente.

Mount Kinabalu, Maraiparai Spur, *Mrs. Clemens 11033*.

An exceedingly well-marked species of the group of *Cyathea Brunonis*, from which it differs in the stout stipe and rachis of darker color, less scattered sori, anastomosing veins and wholly distinct apex. The anastomosis of the veins, as a feature correlated with broad, entire laminae of

frond or pinna, duplicates conditions already familiar in many other genera, *Athyrium*, *Dryopteris*, *Polypodium*, etc.

Cyathea Brunonis Wall. has of late been treated as identical with *C. moluccana* R. Br.; this may be proper, but with five or six Bornean species in the group, distinguished now by the apex of the frond, now by the base of the stipe, I would want to compare complete specimens, rather than very imperfect descriptions, before I believe it. I do not know *Cyathea moluccana* at all, but have in hand four sheets of *Cuming 378*, cited by Hooker with the description of *C. Brunonis*.

CYATHEA PSEUDOBRUNONIS sp. nov.

Fragmentum solum a C. J. Brooks ad Bidi in Sarawak anno 1907 lectum et sub nomine C. Brunonis sine numero distributum adest; qua specie rhachi validiore, pinnis longioribus, marginibus plus parallelis ubique crenato-sinuatis, textura crassiore, venis simplicibus multis, et praecipue indusiis nullis vel mox fugacibus distinguendum est. Rhachi castanea glabrescente; pinnis brevistipitatis, basi superiore truncatis inferiore truncato-cuneatis, ca. 30 cm longis, 3 cm latis; soris irregulariter 3-seriatis, ad venas simplices plerumque carentibus.

The main veins are notably stout, with usually four, less frequently three or five branches; and between them are usually two simple veins, leaving the costa near the main veins or at any points between them. There are no entire sori on my specimen, but many from which few sporangia have been shed; and no trace of an indusium can be detected. On Cuming's specimens of *Cyathea Brunonis*, collected about eighty years ago, the indusium can be seen a meter away with the naked eye, though the sporangia of many sori are entirely gone.

CYATHEA FUSCOPALEATA sp. nov.

Verosimiliter arborescens, sed caudice ignoto; stipite 75 cm alto, parte inferiore 20 cm longa paleis linearibus 1 ad 2.5 cm longis fuscis minute ciliatis dense vestita, sursum rhachique fusco-stramineis, glabris; fronde 75 ad 100 cm alta, 35 ad 45 cm lata, pinnata, pinna apicale aliis simile, minore; stipitulis pinnarum 3 ad 10 mm longis, basibus nigro-fuscis ad rhachin articulatis; pinnis majoribus inferioribus 16 ad 22 cm longis, 25 ad 35 mm latis, anguste lanceolatis, basi rotundatis vel interdum rotundato-cuneatis, apice acuminatis, rectis vel falcatis, apices versus serratis, alibi integris, subcoriaceis, glabris; venis 1 ad 3 furcatis, inter eas 0-2 simplicibus, proximis, liberis; soris 1- ad 3-seriatis, costae approximatis, exindusiatis.

Sarawak, Siol, *native collector 2503*, February–June, 1914.

Other collections probably representing this species, but without the base of the stipe, are *2657* from Mount Merinjak, and *1568*, without stated locality; *No. 68*, the frond of a young plant, cannot now be determined to the species.

This is perhaps nearest to *Cyathea articulata*, from which it differs in the narrower pinnae and closer venation and sori, as well as in the paleae.

CYATHEA KINABALUENSIS sp. nov.

Caudice erecto haud arborescente; stipite 75 cm alto vel altiore, deorsum atro-castaneo, ad pedem paleis rufo-stramineis anguste linearibus ciliatis 2 ad 2.5 cm longis dense vestito, sursum rhachique fuscis vel castaneis glabris vel minute et sparsissime squamulatis; fronde 75 cm alta vel multo altiore; pinna apicale aliis simile; stipitulis pinnarum 5 ad 20 mm longis; pinnis majoribus inferioribus usque ad 25 cm longis et 4 cm latis, basi rotundatis vel oblique cuneatis, apicibus acuminatis vel caudatis, rectis vel falcatis, praecipue apices versus serratis, papyraceis, glabris; venis plerisque 3-furcatis et sine venis simplicibus interpositis; soris plerisque irregulariter biseriatis, a costa remotis, exindusiatis.

Mount Kinabalu, Gurulau Spur, *Mrs. Clemens 10840* (type), *10861*, *Topping 1634*.

Most nearly related to *Cyathea arthropoda*, from which it differs in its darker axes and relatively narrower pinnae with more nearly parallel sides, as well as in the long paleae.

Whoever is disposed to rename some of these species in *Alsophila* should have difficulty in overlooking the fact that they are nearly related to *Cyathea Brunonis* and *C. capitata*, but not at all nearly so to *C. extensa* (Forst.) Swtz.

CYATHEA TOPPINGII sp. nov.

Rhachi fusco-purpurea, sub lente minute furfuracea; pinnis stipitulatis, sterile 35 cm longa, 9 cm lata, rhachi atropurpurea, superne velutina, alibi glabra vel glabrescente; pinnulis brevistipitulatis, 4.5 cm longis, 1 cm latis, acuminatis, basi truncatis, majoribus fere $\frac{1}{2}$ ad costam pinnatifidis, costis nudis atropurpureis, lobis proximis, obliquis, subacutis, ca. 2.5 mm latis, obscure crenulatis, subcoriaceis, inferne pallidis; venis utroque latere ca. 3, obliquis, simplicibus; pinna fertile angustiore, pinnulis 20 ad 25 mm longis, vix 5 mm latis, crenatis; soris contiguis, nudis.

Mount Kinabalu, Gurulau Spur, *Topping 1824*.

In the small group with distinct fertile and sterile fronds or pinnae; distinguished from *Cyathea dimorpha* (Christ) by having the fertile pinnules less cut than the sterile; and from *C. Hewittii* Copel. by the much smaller and more numerous lobes of the sterile pinnules; much less obviously related to *C. glabra* than is *C. Hewittii*.

CYATHEA ELLIPTICA sp. nov.

Adsunt basis et pars apicalis frondis; rhachi deorsum atrofusca, 6 mm crassa, superne piloso-velutina, ibidem et praecipue

ad latere paleis atrocastaneis squarrosis 5 ad 7 mm longis lanceolatis subulatis integris rigidulis dense vestita, inferne pilis caducis vestita, tum demum verruculosa, sursum rhachibusque pinnarum pallidioribus, superne setosis, alibi glabris; pinnis infimis horizontalibus, subsessilibus, vix 20 cm longis, 5 cm latis; pinnulis 2.5 ad 3 cm longis, 7 mm latis, obtusis, ellipticis, sessilibus, serratis, infimis minoribus; pinna 40 cm ab apice remota sessile, 30 cm longa, 7.5 cm lata, abrupte acuminata; pinnulis 22-paribus, acutis, 1 cm latis, $\frac{1}{8}$ ad costam lobatis, lobis 2 ad 3 mm latis, obliquis, costis superne deorsum sparse et minute pilosis, inferne paleis fulvis parvis et paucis plerisque bullatis deciduis vestitis, lamina glabra papyracea; venulis ca. 3-paribus, simplicibus; soris ferrugineis, exindusiatis, medio inter costam et marginem saepe confluentibus.

Mount Kinabalu, Gurulau Spur, *Mrs. Clemens 10859*.

This is like the *Alsophila Burbidgei* of Hose and of Christ in having a dense fringe of brown scales on the stipe and lower part of the rachis and is perhaps identical with Hose's plant, at least. Baker described as *Cyathea Burbidgei* a plant without scales and the costae strongly ciliate beneath; the costae of *C. elliptica* are not in the least so. The pinnules are usually abruptly but not greatly dilated at the base.

CYATHEA MOLLIS sp. nov.

Caudice (teste Mrs. Clemens) 1 m alto; stipite 50 cm alto ferrugineo-castaneo, ad pedem paleis fulvis et stramineis linearibus sursum minute serrulatis 1.5 ad 2 cm longis dense immerso, sursum rhachique superne piloso-velutinis, inferne glabrescentibus; fronde 80 cm alta, ovata, longe acuminata, tripinnatifida; pinnis infimis reductis, inframedialibus maximis, subsessilibus, 30 cm longis, 7 cm latis, sensim acuminatis, rhachi superne adpresso-setosa, alibi pilis pallidis 2 ad 3 mm longis vestita; pinnulis multis, fere contiguis, sessilibus, 3 ad 4 cm longis, 1 cm latis, acutis, $\frac{1}{2}$ ad costam pinnatifidis, herbaceis, utraque facie viridibus, costa superne sparse setosa, inferne paleis sparsis minutis plerisque bullatis et subulatis fulvis, et inter eas pilis sparsissimis vestita, costula quaque 1 ad 3 squamulis ornata; lobis ca. 4 mm longis, 3 mm latis, obliquis, obtusis, fere integris; venis utroque latere ca. 4, simplicibus; soris medialibus, minutis, exindusiatis.

Sandakan, *Mrs. Clemens 9440*.

CYATHEA KEMBERANGANA sp. nov.

Caudice et parte basale stipitis ignotis; fronde 75 cm alta, deltoidea, acuminata; rhachi fusca, superne velutina, alibi glabrescente; pinnis infimis 40 cm longis cum stipitula 3 cm longa,

remotis; pinnulis inferioribus 7 cm longis, 15 mm latis, subobtusis, basi truncatis vel subcordatis, ⅔ ad costam pinnatifidis, stipitulis earum 5 mm longis, costis superne nigro-velutinis, inferne venisque majoribus paleis lanceolatis vel ovatis 0.5 ad 1 mm longis atropurpureo-setoso-ciliatis deciduis vestitis, atropurpureis; segmentis proximis, superne vernicoso-nitidis, inferne olivaceis; venis utroque latere ca. 5, simplicibus, rectis, infima inferiore remota e costa emissa; soris medialibus, 1 mm latis, sporangiis pilis brevibus brunneis interspersis, indusio nullo vel inviso.

Mount Kinabalu, Kemberanga, *Mrs. Clemens 10500.*

Probably a near relative of *Cyathea Ridleyi* (Baker), but with lighter axes and stalked pinnules. *C. squamulata* has much more ample fronds, thin in texture, with long, whitish hairs in the sori. *C. recommutata* has dark-purple axes, and less lobed, subdimorphous pinnules.

CYATHEA PALEACEA sp. nov.

Arbor (teste Mrs. Clemens), caudice ut videtur 3 cm crasso apice basibus stipitum paleisque dense immerso; stipite 20 ad 30 cm alto, rhachique ubique densissime paleaceis, paleis pedem stipitis versus 1 cm longis linearibus rigidis atro-castaneo-fuscis integris, ad rhachin et costas inferne pallidioribus laceratis et pilis interpersis praecipue ad costas diversis, superne cum pilis intergradientibus; fronde ca. 50 cm alta, 15 cm lata, acuminata, bipinnata, apice pinnatifida; pinnis infimis deflexis; medialibus, rectis, sessilibus, subacuminatis, 2 cm latis; pinnulis proximis, sessilibus vel plerisque adnatis, obtusis, integris, margine deflexis, rigide coriaceis, costis pallidis superne prominentibus pilis albis longis flaccidis deciduis ornatis, inferne apud rhachin pinnae paleatis, alibi pilis vel squamulis minutis albis appressis ornatis, lamina superne atro-viride, inferne pallidiore; venis usque ad 11-paribus, apud costam furcatis; soris magnis, costalibus, globosis; indusio fusco, persistente, poro aperto, demum in fragmenta pauca fisso.

Mount Kinabalu, Paka Cave, *Mrs. Clemens 10726* (type), *Topping 1669.*

Very distinct from any species hitherto known to me, nearest perhaps to *Cyathea dulitensis* Baker, from which it is distinguished by its extreme scaliness. By description it might seem nearly related to *C. philippinensis* Baker, but I believe there is no near affinity between the two.

CYATHEA RIGIDA sp. nov.

C. paleaceae affinis, rhachibus etenim densius paleatis, tota fronde majore et crassiore, paleis basalibus lanceolato-ovatis in vetustate eroso-ciliatis, infimis remotis et reductis, pinnis erecto-patentibus, 17 cm longis, 5 cm latis, pinnulis 25 mm longis, 5 mm latis, majoribus medio ad costam lobatis, lobis triangular-

ibus, lamina et costis superne nigris; aliter vix C. paleacea distinguenda.

Mount Kinabalu, Paka Cave, *Topping 1758*.

Very distinct in characteristics available for description, but still very possibly a much more ample form of *Cyathea paleacea*. Judging by the material in hand it seems best to regard them as distinct species. *C. Havilandii* Baker is described as subcoriaceous with the lowest pinnae not reduced, and the veinlets simple.

CYATHEA LONGIPES sp. nov.

Adsunt partes mediales et verosimiliter basales frondis; rhachi castanea, superne minute fusco-furfuracea, alibi glabra, inerme; pinnis longissime stipitulatis, usque ad 45 cm longis, 18 cm latis, acuminatis, rhachi superne fusco-pilosa, inferne deorsum nuda, sursum ut costae sed sparsius paleatis; pinnulis stipitulatis, remotis, usque ad 10 cm longis, 2 cm latis, valde acuminatis, basi rotundato-truncatis, fere ad costam pinnatifidis, costa superne minute pilosa, inferne paleis 1 ad 1.5 mm longis ovatis irregularibus fusco-cinereis subpersistentibus haud dense vestita; segmentis proximis, 10 ad 13 mm longis, 4 mm latis, obliquis, subfalcatis, obtusis, serratis, papyraceis vel subcoriaceis, inferne pallidis, costula superne prominente glabra, inferne deorsum sparse paleata, alibi glabra; venis utroque latere usque ad 8 quarum 5- vel 6-furcatis et his plerisque soriferis; soris infra-medialibus, vix 1 mm latis, castaneis, indusio tenue mox fisso.

Mount Kinabalu, Maraiparai Spur, *Mrs. Clemens 10915* (type), *Topping 1850*. Mrs. Clemens's field note states "trunk 3 ft.—frond 10–15 ft." Well marked by the pedicels, those of the pinnae in hand reaching a length of 8 cm, and of the pinnules, 6 mm.

CYATHEA MEGALOSORA sp. nov.

Stipite 45 cm alto, castaneo, deorsum paleis pallide stramineis linearibus 3 cm longis dense vestito, sursum paleis minoribus sparsius vestito et ob baseos nigros irregularies palearum deciduarum aspero; rhachi fusca, superne velutina, alibi minute et sparse verruculosa, paleis cinereis sinuosis vestita; pinnis infimis ut videtur maximis, 35 cm longis, 14 cm latis, acuminatis, brevi-stipitulatis, basin versus subangustatis, bipinnatis, rhachi superne dense hirsuta, inferne paleis cinereis linearibus sinuosis 1.5 ad 3 mm longis appressis cum minoribus interspersis densissime vestita; pinnulis utroque latere ca. 20, subsessilibus, vix 12 mm latis, basin versus pinnatis, sursum pinnatifidis, rhachi ut rhachis pinnae vestita: pinnulis II infimis liberis, sessilibus, oblongis, obtusis, 3 mm latis, sequentibus conformibus adnatis margine deflexis, coriaceis, superne nigris, ad costas et venas sparse pilosis, inferne pallidioribus, costis deorsum dense paleatis,

sursum venisque paleis parvis in pila decrescentibus sparse vestitis; venis ca. 5-paribus, plerisque furcatis; soris medialibus, magnis, laminam totam complentibus; indusio laete fusco, mox fisso, persistente; receptaculo parvo.

Mount Kinabalu, Paka Cave to Lobang, *Topping 1759*.

Cyathea crinita (Hooker) Copel., reported by Miss Gibbs, is less densely paleaceous and has narrower ultimate divisions, beside being exindusiate. The scales of *C. megalosora* are typically entire, but those of the upper axes are soft and flexuous, forming thick mats.

DRYOPTERIS Adanson

DRYOPTERIS INCONSPICUA sp. nov.

Lastraea; rhizomate repente vel suberecto, breve, ca. 4 mm crasso, paleis parvis ovatis apiculatis fuscis sordidis vestito; stipitibus confertis, 15 ad 20 cm usque ad pinnas normales altis, fusco-stramineis, deorsum sparse paleatis, sursum rhachique superne velutinis, inferne glabrescentibus, pinnis subnormales 2- ad 4-paribus remotis ad auriculas reductis ornatis; fronde 25 ad 30 cm alta, 8 ad 12 cm lata, acuminata; pinnis infimis normalibus plerumque deflexis et rhachin versus angustatis; medialibus sessilibus vel brevi-stipitulatis, falcato-acuminatis, basi truncatis, 12 ad 16 mm latis, ad alam 1.5 mm latam costalem pinnatifidis, herbaceis, pilis pallidis minutis dense adpressis vestitis; segmentis obliquis, obtusis, 2 ad 3 mm latis; venis utroque latere ca. 4, simplicibus; soris medialibus; indusio fusco, tenue, nudo.

Mount Kinabalu, Kiau, *Topping 1543* (type); Gurulau Spur, *Topping 1837, 1839*.

Apparently a quite distinct species, characterized by the dwarfed lowest pinnae and peculiar pubescence of costae and veins; but without any one distinctive feature to invite attention in the field.

DRYOPTERIS KINABALUENSIS sp. nov.

Lastraea; rhizomate breve, suberecto, paleis nigris lanceolatis valde acuminatis ca. 6 mm longis vestito; stipitibus confertis, 10 ad 17 cm altis, deorsum paleatis atris vel atropurpureis, sursum glabrescentibus et viridescentibus; fronde usque ad 25 cm alta et 8 cm lata, acuminata, rhachi costisque ubique sed praecipue superne brevissime hirsutis; pinnis liberis utroque latere 15 ad 23, infimis haud brevioribus, paullo deflexis, brevissime stipitulatis, aliis sessilibus, inframedialibus horizontalibus, rhachin versus interdum paullo angustatis deinde truncatis, profunde pinnatifidis, tenuiter chartaceis, superne atroviridibus, punctulis minutissimis albis ornatis, nec carent inferne punctulae; segmentis 2 mm latis, obtusis, decidue ciliatis; venulis ca. 5-paribus, simplicibus; soris medialibus, indusio pallido, tenue.

Mount Kinabalu, Paka Cave, *Topping 1719.*

This is from the same place as *Dryopteris gymnopoda* (Baker) C. Chr. and is certainly much like it; but that species is described as smaller, but with the pinnae cut quite to the costa, and with one sorus on each side at the base of each segment; the latter feature might be expected on occasional young plants of *D. kinabaluense,* but such plants are not likely to be more deeply cut than larger ones.

DRYOPTERIS LINEARIS sp. nov.

Lastraea; rhizomate suberecto, 5 ad 10 mm crasso, lignoso, breve, paleis castaneis lanceolatis acuminatis 1 cm longis dense vestito; stipitibus 30 ad 45 cm altis, atropurpureis, nitidis, deorsum paleis paucis ornatis; fronde usquè ad 50 cm alta et 8 cm lata, acuta, rhachi atropurpurea superne velutina, inferne nitida; pinnis infimis subremotis vix brevioribus, utroque latere 25 ad 35, brevistipitulatis, 35 ad 45 mm longis, 10 ad 15 mm latis, e basi dilatato sensim angustatis, acuminatis, profunde pinnatifidis, costa superne velutina, aliter glabris, coriaceis, inferne pallidis; segmentis proximis, obtusis, majoribus crenatis vel subserratis; venulis utroque latere ca. 5, simplicibus vel infimis in sementis maximis furcatis; soris superioribus in segmento quoque costularibus, inferioribus divergentibus; indusiis magnis, persistentibus, fulvis, interdum inaequalibus (athyrioideis), nudis.

Mount Kinabalu, Maraiparai Spur, *Mrs. Clemens 11069* (type), *11067.*

There is little choice as to whether this should be called *Dryopteris* or *Athyrium.* The conspicuous dark-purple stipes and rachises are duplicated by some similar and probably related species in each genus. I have given this a name in *Dryopteris* because most of the sori are roundish and it is not more nearly related to species known to me in *Athyrium.*

DRYOPTERIS TOPPINGII sp. nov.

Nephrodium, D. extensae (Bl.) O. K. affinis, pinnis stipitulatis rhachin versus decrescentibus, adspectu D. syrmaticae; rhizomate inviso sed de forma pedis stipitis verosimiliter late repente; stipite 50 cm alta, ad pedem paleis fusco-castaneis linearibus 1 cm longis vestito, sursum rhachique minute griseo-velutinis; fronde ca. 75 cm alta, fere 40 cm lata; pinnis rectis, late linearibus, inferioribus remotis non abbreviatis, stipitulatis, et ad rhachin pseudoarticulatis, ca. 20 cm longis, 3.5 latis, acuminatis, medio ad costam pinnatifidis; segmentis proximis, subfalcatis, obtusis, 5 ad 7 mm latis, pinnularum inferiorum infimis valde reductis, pilis pallidis appressis ciliatis, costis et sparsius venis superne velutinis, inferne minute adpresso-pubescentibus, lamina nuda papyracea; venulis ca. 14-paribus, quarum 3 vel 4

anastomosantibus; soris submarginalibus, contiguis, indusio glabro.

Mount Kinabalu, Lobang, *Topping 1766.*

As is true of *Dryopteris extensa,* the position of the sori is sometimes evident on the upper surface.

DRYOPTERIS LITHOPHYLLA sp. nov.

D. alpestris gregis D. cucullata, robustior, rigide coriacea, glabra; rhizomate ut videtur brevi-repente, 5 mm crasso; stipitibus approximatis, validis, 20 ad 25 cm altis, lignosis, basi atropurpureis, sursum fusco-stramineis, glabris, ubique pseudopinnis usque ad tuberculas abrupte reductis donatis; fronde 25 ad 30 cm alto, ca. 10 cm lata, acuminata, rhachi et costis superne velutinis exceptis glaberrima; pinnis proximis, subsessilibus subfalcatis, erecto-patentibus, usque ad 8 cm longis et 15 mm latis, acuminatis, basin versus infimis angustatis, aliis truncatis, profunde dentatis, dentibus oblique deltoideis, acutis; venis conspicuis, ca. 10-paribus quarum 4 anastomosantibus; soris medialibus, indusio parvo glabro, fusco.

Mount Kinabalu, Maraiparai Spur, *Topping 1850½.*

Like *Gleichenia crassifolia* in texture.

MESOCHLAENA R. Brown

MESOCHLAENA TOPPINGII sp. nov.

M. polycarpae similis, pilis rhachidis longioribus et pinnis inferioribus triangulari-hastatis imbricatis distincta; stipite usque ad pinnas infimas reductas 5 cm alto, paleis pilosis linearibus fuscis 10 ad 15 mm longis vestito; parte inferiore frondis lineare, 35 ad 55 cm alto, pinnis ibidem hastato-triangularibus, sursum 2 cm longis, 2.5 cm latis lobis lateralibus recurvatis, late imbricatis; fronde vera 45 ad 60 cm alto, 25 ad 30 cm lata, pinnata, rhachi pilis albis 1.5 vel 2 ad 2.5 mm longis vestita; pinnis fere horizontalibus, sessilibus, 12 ad 15 cm longis, sterilibus 2 cm, fertilibus 10 ad 15 mm latis, acuminatis, basi subhastato-truncatis, ad mediam laminam pinnatilobatis lobis obtusis, lamina papyracea, superne ad costas subadpresso-pilosis, ad venulas pilis sparsis longis ornatis, inter venulas nudis, inferne costis venis et venulis pilosis, lamina inter venulas glandulifera; venulis ca. 9, quarum 2 vel 3 anastamosantibus; indusio elliptico, praecipue ad lineam medialem obscuram dense minute piloso, marginem versus pallido, ad marginem ipsum densissime glandulis minutis obsito.

Kinabalu neighborhood, between Keung and Kibayo, *Topping 1902.*

Mesochlaena polycarpa has a much less conspicuous development of the

reduced lower pinnae, shorter hairs on the rachis, decidedly finer and closer pubescence on the nether surface, and less ornate indusia.

Mr. Topping remarks that he regards this as the most strikingly beautiful fern he has collected.

TECTARIA Cavanilles

TECTARIA MURUDENSIS sp. nov.

Sagenia, Nephrodio ternato Baker, Syn. Fil. 296, affinis, in alas pinnarum glandulifera; rhizomate repente, 5 mm crasso; stipite 35 ad 40 cm alto, fusco, deorsum sordide adpresso-paleato, sursum frondeque glabris; fronde ternata, pinnis elliptico-lanceolatis, valde caudatis, integris; pinna apicale stipitata, usque ad 30 cm longa et 8 cm lata, basi cuneata; pinnis lateralibus sessilibus, paullo minoribus, subcultratis, ad pedem quaeque glandula squamulosa conspicua praditis, papyraceis; venis conspicuis, patentibus, marginem fere attingentibus et ibidem curvatis; soris plerisque apud venis seriatis, nec carent alii irregulariter adspersi; indusio sat persistente, reniforme, lobis interdum imbricatis, parvo.

Sarawak, foot of Mount Murud, *native collector 2905* (type), *2945* (*Bur. Sci.*).

This differs from *Tectaria ternata*, of which I have an apparently typical specimen, in color of stipe and veins, rather firmer texture, more divergent veins, cuneate base of central segment, and in the conspicuous "glands." The latter probably are very dwarfed buds, and suggest affinity to proliferous species. They are uniform on the three fronds in hand. *T. subcaudata* (v. A. v. R.) is described as having a distinctly different rhizome, and fugacious indusia.

ATHYRIUM Roth

ATHYRIUM CLEMENSIAE sp. nov.

A. gregis A. nigripedis, A. Sarasinorum et A. philippinensi simile, quibus praecipue fronde compacta pinnis imbricatis stipite rhachique carnosis distinctum; caudice breve, suberecto, valido, radicibus paleisque immerso, paleis badiis vel castaneis, linearibus; stipite plantae typicalis alpestris 5 ad 8 cm alto, ad pedem dense paleato, alibi paleis angustis ca. 5 mm longis sparsis ornato, sursum glabrescente; fronde ovata, 5 ad 8 cm alta, bipinnata; pinnis brevi-stipitatis, anguste ovatis, obtusis, utroque latere 7 ad 10, deorsum accrescentibus; pinnulis paucis, oblongis vel ellipticis, obtusis, infimis stipitulatis incisis, plerisque confluentibus, crenatis; soris lineari-oblongis, vel late oblongis; indusiis asplenioideis rarius forma typica Athyrii, interdum diplazioideis vel reniformibus, neque carent indusia formis aliis, e. g., Acrophori et Leucostegiae.

Mount Kinabalu, summit of Low's Peak, in rock crannies, *Mrs. Clemens No. 10621,* November, 1915.

The diagnosis just given applies to the form at greatest altitude, where the general appearance seems to be fairly fixed. With decrease of altitude and exposure the fern of course grows more freely, down to its lower limit, which, so far as our collections show, is about the Paka Cave. *Topping's No. 1698*, from between the cave and the summit, has some stunted fronds, but also some 15 cm high and equally wide. His *No. 1705* from the immediate vicinity of the cave, has the tripinnatifid fronds ovate and 20 to 25 cm high, with much the aspect of *A. nigripes*, but still with brown, not very dark scales, and the stipe still somewhat fleshy.

Euathyrium reaches its best development in species in the extra-tropical Orient; but within the tropics, each mountain of sufficient height has a group of apparently and probably local species. In this group we have now one species from two Celebes peaks, this one of Kinabalu, and one from Mount Data, Luzon. A somewhat different line of evolution from the same near parent stock is represented on Data, Kinabalu, and the Pangeranggo.

ATHYRIUM ATROPURPUREUM sp. nov.

A. gregis A. Filix-foeminae, A. drepanopteronti similis, eo paleis, stipitibus et pube atro-purpurescentibus, lamina tenuiore distinctum; rhizomate suberecto; stipitibus confertis, plerisque atropurpureis, aliis pallidioribus, ca. 20 cm altis, pedibus paleis lanceolatis acuminatis 5 mm longis sparse vestitis, sursum relictis palearum minutarum asperulis; fronde 20 ad 25 cm alta, lanceolata, acuminata, deorsum non angustata, tripinnatifida; pinnis majoribus 5 cm longis, 20 ad 25 mm latis, deltoideo-lanceolatis, acuminatis, brevipedicellatis, rhachibus sursum vel ubique alatis; pinnulis sessilibus vel adnatis, oblongis, pinnatifidis vel sursum dentatis; segmentis acutis, integris vel furcatis; lamina papyracea vel chartacea, superne pilis et squamulis minutis deciduis sparse vestita, obscura; venis nigris; soro in segmento quoque uno, laminam ejus fere complente; indusiis polymorphis, plerisque dryopteroideis, aliis (parvis) forma Leucostegiae, aliis athyrioideis.

Mount Kinabalu, Low's Peak, *Mrs. Clemens 10620, Topping 1696.*

ATHYRIUM ATROSQUAMOSUM sp. nov.

Diplazium, A. Blumei affine, soris brevibus, lamina tenuiore, stipite deorsum paleis angustissimis nigris nitidis asperis subcrinitis 5 ad 12 mm longis dense vestito; stipite 40 cm alto, deorsum nigro sursum sordide brunneo-stramineo; rhachibus in sulcis dorsalibus pilosis, alibi paleis paucis parvis irregularibus deciduis ornatis; fronde 1 m alta, 60 cm lata, triangulari; pinnis sat remotis, stipitatis, acuminatis, infimis 35 cm longis; pinnulis

multis, stipitulatis, inferioribus et submedialibus ca. 12 cm longis, 15 mm latis, valde acuminatis, basi truncatis, fere ad costam nigram pinnatifidis, segmentis 3 ad 4 mm latis, oblongis, obtusis, serrato-dentatis; venis fere omnibus simplicibus; lamina papyracea, inferne subpallidiore glabra; soro infimo solummodo saepe diplazioideo; soris costularibus, brevibus, indusio laete brunneo.

Mount Kinabalu, Maraiparai Spur, *Mrs. Clemens 11051.*

This fern has the remarkable coat of absolutely black scales, completely clothing the apex of rhizome and base of stipe, characteristic of *Athyrium meyenianum;* in other respects it is much like *A. Blumei,* except in the details noted above.

POLYPODIUM Linnaeus

POLYPODIUM KINABALUENSE sp. nov.

Grammatis minuta, rhizomate erecto, apice paleis pallidis minutis lanceolatis vestito; stipitibus permultis confertis, usque ad 5 cm longis castaneis, glabris, erectis; frondibus lineari-oblanceolatis, 3 ad 5 cm altis, 2.5 ad 4 mm latis, obtusis, deorsum sensim angustatis, glabris, tenuiter coriaceis; venis furcatis ramis subaequalibus, ramo superiore apud furcam sorifero; soris superficialibus vel levissime immeris, vix elongatis.

Mount Kinabalu, altitude 3,700 meters, *Mrs. Clemens 10649* (type), *10618* partim.

A very distinct little fern of the Alpine summit. Mixed with *No. 10649* is one small plant which may be a *Scleroglossum.*

POLYPODIUM BROOKSII sp. nov.

Polypodium hirtellum Brooks in Sarawak Mus. Journ. 1 (1912) 49, non Blume.

Grammitis, rhizomate suberecto, paleis pallide brunneis ovatis obtusis vel acutis vestito; stipitibus confertis, haud articulatis, filiformibus, 0.5 ad 1 cm longis, pilis vinicoloribus 1 ad 2 mm longis ornatis; fronde 4 ad 7 cm alta, plerumque ca. 3 mm, rarius usque ad 5 mm lata, obtusa vel subacuta, deorsum sensim angustata, integra, subcoriacea, ubique setosa, setis usque ad 3 mm longis, rubidis; venis sterilibus plerisque simplicibus, fertilibus prope costam furcatis, soro orbiculare ramum superiorem brevissimum insidenti et complente, receptaculo subelongato.

Sarawak, Mount Bongo, *Brooks,* February, 1908.

So far as one might judge from diagnoses, this might be *Polypodium lasiosorum* Hooker; but study of Javan material satisfies me, as it has Blume, Beddome, and others, that the latter is only a small form of *P. hirtellum* Bl., with forks of the veins subequal. I have never seen *P. hirtellum* except in Javan material. Beddome, Ferns of British India 172, 212, twice figures a Ceylon fern, probably similar in venation to that described here, although he describes the veins on page 172 as simple; we have this

fern in Luzon and have called it *P. hirtellum* in error. I now believe it to be *P. Reinwardtii*. *Grammitis nana* Fée is also described as having simple veins; whatever it is, the name cannot be transferred to *Polypodium*. As to the venation of *P. lasiosorum*, van Alderwerelt, Malayan Ferns 580, says "veins not discernible,"—which may depend on how it is examined.

My specimens of *Polypodium Brooksii* are somewhat old and the sporangia seem to be naked; those of *P. Reinwardtii* and *P. hirtellum* bear a few setae.

POLYPODIUM CALCIPUNCTATUM sp. nov.

Grammitis P. Frederici et Pauli Christ affinis, subglabra et punctulis calcareis ornata; rhizomate erecto, paleis lanceolatis fulvis dense ciliatis vestito; stipitibus confertis, 3 ad 4 cm longis, gracilibus, pilis 2 ad 2.5 mm longis pallidis et rubis vestitis; fronde pendente, usque ad 25 cm longa, ca. 13 mm lata, linguiforme, subacuta, deorsum angustata, integra vel rarius obscure et late crenulata, crassa, superne glabrescente et ad apices venularum albo-punctata, inferne sparse pilosa; venis utrinque pinnatis, immersis; soris irregulariter a costa fere ad marginem adspersis, superficialibus, orbicularibus, inter sporangia pilis paucis.

Mount Kinabalu, Kemberanga, *Mrs. Clemens 10530.*

While near to *Polypodium Frederici et Pauli* of Celebes, this fern has a narrower frond, with parallel sides and the form of a narrow *P. setigerum*, less conspicuous and almost naked costa, and thicker texture.

POLYPODIUM MULTISORUM sp. nov.

Grammitis, praecedente (P. calcipunctato) affinis; rhizomate breve, suberecto, radicibus et sursum basibus stipitum omnino obtecto, paleis veris ob dissectionem ipsarum in pilos minutos pallidos carentibus; stipitibus multis confertis, 2 ad 4 cm longis, filiformibus, pilis pallidis usque ad 2 mm longis densissime hirsutis; fronde ca. 15 cm longa, 8 ad 12 mm lata, utrinque angustata, subacuta, integra vel saepius late crenata, subcoriacea, superne glabrescente, inferne ubique pilosa; venis sinuatis, irregulariter utrinque pinnatis; soris irregulariter adspersis vel sub-3- vel 4- seriatis, oblongis, densissime pilosis, superficialibus.

Mount Kinabalu, Paka Cave, *Topping 1665* (type) *1668, 1682, 1711. No. 1682* is immature and might be confused with other species.

While more like *Polypodium Frederici et Pauli* in form and texture, this fern is clearly distinguished by the elongate sori, which remain clearly marked by dense tufts of hairs, after the sporangia are removed.

POLYPODIUM MURUDENSE sp. nov.

Eupolypodium pinnatifidum anguste lineare; "rhizomate" erecto, breve, paleis ovato-lanceolatis brunneis inter stipites vestito; stipitibus confertissimis, ca. 2 mm altis, vel 1 cm altis et sursum alatis, pilis paucis albidis ornatis, mox glabrescentibus; fronde 6 ad 9 cm alta, 2.5 mm lata, in dentes triangulares obtusos

pinnatifida, in vernatione pilis brevissimis albidis vestita, glabrescente, papyracea, sinubus inter dentes dentibus ipsis reversis aequalibus; vena in dente quoque una, simplice, soro tantum uno, inframediale, subsuperficiale.

Mount Murud, *native collector, 2924* (Bur. Sci.), December, 1914.

Nearer to *Polypodium subpinnatifidum* than to *P. alternidens;* differing from the former in having almost sessile, narrower fronds and triangular, not rounded, segments; from the latter in the closer teeth and thinner texture.

POLYPODIUM BRACHYPODIUM sp. nov.

Species P. colorato Copel. similis et affinis, paleis mollioribus integris distincta; rhizomate 3 ad 4 mm crasso, calcareo, paleis rufo-castaneis peltatis sensim in caudam angustatis 5 mm longis integris mollibus vestito; phyllopodiis brevissimis; stipitibus inter se ca. 4 mm distantibus, 10 ad 18 cm altis, glabris, atro-fuscis vel (frondium juvenalium) stramineo-fuscis; fronde usque ad 30 cm alta et 7 cm lata, acuminata, pectinata, vix deorsum angustata, rhachi atro-fusca, nuda; segmentis utroque latere usque ad 60, fere horizontalibus, 3 ad 4 mm latis, acutis, apices versus serrulatis, ala angusta confluentibus, papyraceis vel subchartaceis, opacis, infimis decurrentibus; venis deorsum seriem unam areolarum includentibus, aliter liberis, furcatis, venis inclusis nullis, apices versus segmentorum liberis, furcatis, tum demum simplicibus; soris ad ramos inferiores acroscopicos venarum, costae quam margini propioribus, superficialibus, parvis, utroque latere costae usque ad 18.

Mount Kinabalu, Gurulau Spur, *Topping 1823* (type), *1620;* Lobang, *Mrs. Clemens 10354;* Kiao, *Mrs. Clemens 10225.*

Very similar in appearance to *Polypodium coloratum,* but larger than any known specimens of the latter, with closer fronds, and distinctly different paleae; the costae of the segments are straight in *P. brachypodium,* but wavy above the middle in the type of *P. coloratum.*

Polypodium cesatianum Baker is probably a fern of this most interesting Bornean group, as is certainly true of the fern described under that name, as a *Eu-polypodium,* by van Alderwerelt, Malayan Ferns, 603. In my judgment, this name is without standing in systematic botany. Baker published it without a diagnosis, merely stating that Beccari's plant, *P. papillosum* Cesati, non Blume, was a distinct species. Cesati suggests differences from true *P. papillosum,* by saying that such may be due to the state of development of his very small specimen; but all he tells about it is that it agrees with *P. papillosum* in not having the lower pinnae reduced—which certainly is no diagnosis. Beccari and Christ merely list the plant; and the first description, based on a collection by Hallier instead of on the original, was published by van Alderwerelt, *in English and in 1909.*

Judging by place of collection, Beccari's plant is likely to be *P. coloratum* Copel., 1908, which I published without suspecting that I might have *P. cesa-*

tianum, supposed at that time to have free veins. *P. cesatianum* is described by van Alderwerelt as having brown paleae and the margin "slightly, not regularly crenate;" it may be *P. coloratum* or may not; at any rate, the two are closely related. If *P. cesatianum* Baker is neither *P. coloratum* nor the plant collected by Hallier, it still awaits description. If all three are distinct, some good botanical lawyer should decide what plant should be called *P. cesatianum*. Was the type collected by Beccari or by Hallier? Has a *nomen nudum*,—such as *P. cesatianum* was before 1909, and under our strictest rules still is—and, as such, invalid, a type valid enough to fix the application of the name? Or could van Alderwerelt, intentionally or inadvertently, choose a new type specimen to go with Baker's name? Is it *P. cesatianum* Baker or *P. cesatianum* v. A. v. R.?

POLYPODIUM OCCULTIVENIUM sp. nov.

Species P. rupestri Bl. affinis; rhizomate repente, paleis rufo-brunneis peltatis sub insertione non protractis supra basin anguste lanceolatis apicibus longis setiformibus dense vestito; stipitibus approximatis, fronidum sterilium ca. 4 cm, fr. fertilium ca. 10 cm altis, fusco-stramineis, nudis, rectis; fronde sterile 13 ad 16 cm longa, 2.5 ad 3.5 cm lata, lineari-elliptica, integra, coriacea, glabra, apice rotundata, basi acuta; costa inferne prominente, venis inconspicuis; fronde fertile paulo longiore; soris inter venas biseriatis, multis, superficialibus.

Sarawak, Bidi, *Brooks*, May, 1909.

Polypodium rupestre Bl. differs from this in having darker, less dense, and less setiform paleae, acuminate fronds broadest near the base, and more rigid texture.

POLYPODIUM ALBIDO-PALEATUM sp. nov.

Species P. triquetro Bl. affinis; rhizomate repente, nigro, rugoso, 4 mm crasso, paleis ochroleucis vel albidis peltatis et sub insertione protractis anguste ovatis apicibus acuminatis deciduis donatis tum demum omnino deciduis vestito; stipitibus remotis, fuscis vel atro-fuscis, validis, 7 ad 12 cm altis; fronde 25 ad 40 cm alta, 7 ad 8 cm lata, elliptico-lanceolata, abrupte brevi-acuminata, basi rotundata vel subcuneata, integra vel apicem versus subserrulata, rigide coriacea, glabra; costa et venis primariis praestantibus; soris parvis, inter venas biseriatis vel subirregulariter adspersis inter costam et marginem usque ad 18, superficialibus.

Mount Kinabalu, Paka Cave to Lobang, *Topping 1749* (type); Marai-parai Spur, *Mrs. Clemens 11060.*

Polypodium triquetrum Bl. has larger, darker and more persistent paleae, smaller and distinctly lanceolate fronds and larger and less numerous sori, regularly arranged in double rows. The confusion of *P. triquetrum* and *P. rupestre*, in various compendia, can be due only to failure to observe the paleae.

POLYPODIUM ITHYCARPUM sp. nov.

Species gregis P. nigrescentis Bl.; stipite 25 cm alto vel altiore; fronde spectabile ultra 50 cm alta, late ovata, ad alam 5 ad 10 mm latam pinnatifida; segmentis ultra 35 cm longis, 3 ad 5 cm latis, integris, glabris, membranaceis, angulo 45° distantibus, costa valida, plerumque ad basin deflexa; venatione inconspicua; soris utroque latere costam prope uniseriatis, inter se remotis, superne 1 mm elevatis, truncatis, usque ad 3 mm latis.

Mount Kinabalu, Kiau, *Topping 1578* (type), a small frond; Lobang, *Topping 1778*, a fragment of a large frond.

On the specimens collected, the tips of every segment except one stunted one are broken off in collection or drying; the longest fragment is 35 cm long. In spite of the great size, and the thinness, the venation is no more conspicuous than that of *P. punctatum* (L.) Sw. The plant is further distinguished from *P. nigrescens* and *P. longissimum* (which are not easily distinguished in Borneo) by the even more prominent sori, the distance between them, and their remoteness from the margin.

CYCLOPHORUS Desvaux

CYCLOPHORUS BORNEENSIS sp. nov.

Niphobolus gregis C. floccigeri; rhizomate late repente, 2.5 mm crasso, nigro, dense paleato, palearum basibus peltatis nigris, pallido-marginatis, paleis anguste lanceolatis, castaneis, griseo-marginatis, deinde sursum griseis, longissime attenuatis, rectis vel subcrispis, patentibus, integris; stipitibus remotis, 3 ad 6 cm altis, albo-floccigeris, glabrescentibus; fronde ca. 25 cm alta, 10 ad 12 mm lata, utrinque sensim angustata, coriacea, margine sicco deflexo, superne pilis fulvis longe-stellatis deciduis vestita, nec punctata nec squamulosa, inferne tomento denso et profundo occulta, pilis stellatis saepe seta erecta centrale obscura ornatis, ramis aliis saepius pallidis; venis liberis omnibus excurrentibus, in areola quaeque plerumque 3; soris irregulariter ca. 4-seriatis, laminam totam complentibus, haud ad partem distalem frondis restrictis.

Mount Kinabalu, Kiau, *Topping 1508*.

OREOGRAMMITIS Copeland genus novum

Frondibus confertis, stipitatis, simplicibus, integris, parvis; venis (nisi soriferis) liberis; soro costa parallelo et proximo, lineare, superficiale, nudo; paraphysibus nullis. Genus Eupolypodio derivatum.

OREOGRAMMITIS CLEMENSIAE sp. nov.

Rhizomate adscendente, brevissimo, paleis pallido-fuscis lanceolatis vel ovatis acutis 2 ad 3 mm longis dense obtecto; stipitibus

filiformibus, castaneis, 1.0 ad 2.5 cm altis; fronde lineari-oblanceolata, 1.5 ad 3.0 mm lata, 2 ad 3 cm longa, obtusa, deorsum sensim attenuata, subcucullata, subcoriacea, fusca, pilis sparsissimis concoloribus mox deciduis vestita; venis inconspicuis, simplicibus vel furcatis; soris usque ad 12 mm longis, subapicalibus, lateribus frondis deflexis protectis.

Mount Kinabalu, Low's Peak, altitude 3,670 meters, *Mrs. Clemens*, mixed with *No. 10618*, the remainder of which is *Polypodium kinabaluense*.

This fern differs from *Scleroglossum* in the very essential feature of its strictly superficial, or even slightly elevated sori. The filamentous stipes, leaving the short rhizome or caudex with a conpicuous covering of paleae, also give it a quite distinct appearance. The protection of the sori by the deflexed sides of the arched apex is mechanically like that already known in the case of *Hymenolepis platyrhynchos;* and in both cases the protection tends to be raised and so to expose the sorus when the frond is dry, but to fold down when it is wet.

In its characters, *Oreogrammitis* stands between *Scleroglossum* and *Polypodium*, and possibly illustrates the origin of the former; but as it is known only from the isolated summit of Kinabalu, it seems more likely that it is an independent offshoot.

SCLEROGLOSSUM van Alderwerelt van Rosenburgh

SCLEROGLOSSUM ANGUSTISSIMUM sp. nov.

Rhizomate suberecto, basibus stipitum, radicibus filiformibus rigidis atrofuscis, atque paleis lanceolatis integris pallido-fuscis usque ad 5 mm longis 1 mm latis acutis, densissime obtecto; stipitibus ut placet, aut nullis, aut alatis et 1 ad 4 cm altis, complanatis; fronde lineari-spatulata, parte subapicale fertile 5 ad 10 mm longa, 1.5 mm lata, deorsum ad alam usque ad caudicem protractam stipitis sensim angustata, apice obtusa, coriacea, glabra; costa haud prominente, usque ad apicem attingente; venis brevibus, liberis, immersis; soris intramarginalibus, fere ad costam immersis, sulcis decurrentibus, paraphysibus nullis.

Mount Kinabalu, Marai Parai Spur, *Mrs. Clemens 11048*. An unmistakable *Scleroglossum*, but with more the form and size of a *Monogramma*. From above Paka Cave, we have a single specimen of another small *Scleroglossum*, mixed with the type collection of *Polypodium kinabaluense;* until more material may be brought in, I am not sure that it is not a dwarfed specimen of *S. pusillum*.

146016——5

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KOORDERSIOCHLOA JAVANICA MERRILL, A NEW GENUS AND SPECIES OF GRAMINEAE FROM JAVA

By E. D. MERRILL[1]

(From the botanical section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

ONE PLATE

KOORDERSIOCHLOA[2] Merrill genus novum *Gramineae-Aveneae.*

Spiculae pauciflorae, laxe paniculatae, rhachilla supra glumas inferiores elongata et valde hirsuta; rhachilla inter flores valde elongata et articulata, infra (=rhachilla propia) glaberrima, supra (=callus) hirsuta, floribus inferioribus hermaphroditis, superioribus masculinis; glumae superiores vacuae. Glumae 2 inferiores vacuae, sub articulatione persistentes, inaequales, lanceolatae, acuminatae, obscure carinatae (gluma minor obscure 3-nervia; gluma major distincte 5-nervia, nervis subparallelis). Glumae florentes anguste lanceolatae, submembranaceae, 7-nervae, dorso rotundatae, apice acuminatae et 2-dentatae quam vacuae multo longiores, dorso sub apice arista longa torta tenui haud geniculata instructae. Glumae superiores florem ♂ foventes; ultimae valde reductae, ananthae. Palea angusta, 2-carinata, apice obscure 2-dentata. Stamina 3. Ovarium glabrum. Styli breves, distincti, ovarii apice inserti, stigmatibus plumosis. Caryopsis oblonga, glabra, leviter compressa, obscure sulcata, libera, apice appendiculata et stigmatum reliquiis coronata. Gramen elatum foliis planis, habitu *Avenae Junghuhnii* Büse. Ligula elongata. Paniculae ramuli capillares, spiculis longiusculis, nutantibus, glumis imbricatis, florentibus 4 vel 5, superioribus 2 vel 3 valde reductis, vacuis, aristae conjunctim contortae.

KOORDERSIOCHLOA JAVANICA Merrill sp. nov.

Culmo erecto, 1 m alto, basi 2 ad 3 mm diametro, minutissime scaberulo. Foliorum vaginae internodia superantia, striatae, minutissime scabridae; ligula elongata, glabra, fissa, 5 ad 7 mm longa, infra leviter incrassata, supra submembranacea, lobis obtusis, circiter 2 mm latis; lamina anguste lanceolata, attenuato-

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[2] Nomen e cl. Koorders et *chloa* (χλόα).

acuminata, circiter 15 cm longa et 7 mm lata, membranacea, glabra vel junioribus subtus leviter ciliato-pilosa. Panicula exserta, angusta, laxa, circiter 15 cm longa, glabra, rami pauci, tenues, adscendentes; pedicelli graciles. Spiculae lanceolatae, circiter 2 cm longae (aristis exceptis). Glumae 2 inferiores steriles glabrae, lanceolatae, acuminatae; gluma minor, 8 ad 9 mm longa et 1.2 mm lata, obscure carinata et obscure 3-nervia; gluma major 11 ad 12 mm longa et 1.6 mm lata, distincte 5-nervia. Rhachillae articulis 4 mm longis (rhachilla propria glaberrima, 2 mm longa; callus dense hirsutus, 2 mm longus). Glumae fertiles plerumque 4, 12 ad 14 mm longae et 2.5 mm latae, glabrae, 7-nerviae, apice acuminatae et 2-dentatae, dorso rotundatae, arista tenui, contorta, haud geniculata, 4 cm longa, circiter 3 mm infra apicem inserta; glumae superiores valde reductae, vacuae. Caryopsis anguste oblonga, leviter compressa, glabra, 5 ad 6 mm longa, indistincte sulcata, apice appendiculata et stigmatum reliquis coronata.

Java orientalis, Prov. Besoeki, Idjen Plateau, in sylvis *Casuarinae montanae*, leg, *Koorders 40846β*, *alt.* 1,800–2,000 m. s. m., July 21, 1916.

A remarkable grass, well characterized by its narrow, lax panicles; its very slender, twisted but not geniculate awns, which are much longer than the spikelets, those of each spikelet closely twisted together; and its elongated rachilla joints. The space between the flowering glumes is about 4 mm, of which 2 mm is the slender, glabrous, rachilla proper, and the other 2 mm the somewhat thickened, prominently hirsute callus. The lower one or two flowers are perfect, the succeeding two or three staminate, while the uppermost two glumes are very greatly reduced, empty, the last one practically reduced to a very slender awn 5 to 6 mm in length which terminates the rachilla.

I was at first disposed to place this apparently undescribed genus in the *Eufestucae*, near the genus *Festuca*, but it is apparently better placed in the *Aveneae*, near the Australian genus *Amphibromus* Nees. It differs from *Amphibromus* in its more numerously nerved empty and flowering glumes, the later toothed, not cleft; its twisted but not geniculate awns; and its caryopsis, which is obscurely sulcate. Regarding the awns of *Amphibromus* Steudel states "valvula inferior * * * infra apicem membranaceum bifidum vel tridenticulatum aristata, arista stricta (siccando ad horizontem reflexa nec geniculata)." Bentham describes the awns as "florentes * * * medio dorso arista torta geniculataque tenui instructae" and in his Flora Australiensis as "Flowering glumes * * * with a dorsal twisted and bent awn attached at about the middle."

Australian material representing *Amphibromus neesii* Steud., for which I am indebted to Mr. J. H. Maiden, director of the Botanic Garden, Sydney, N. S. W., and a specimen in the Buitenzorg Herbarium, collected by *Reader*, shows that this genus is radically different from *Koordersiochloa* in many characters, including its much smaller spikelets, the flowering glumes awned from about the middle of the back, the awn prominently geniculate or bent. The awns are, moreover, free and spreading, not twisted together in the manner so characteristic of *Koordersiochloa.* In *Amphibromus* the callus, while prominently bearded, is much shorter than are the joints of the rachilla. The alliance of *Koordersiochloa* with *Amphibromus* was originally determined from the description of the latter genus, and now that specimens are available for purposes of comparison, I am still of the opinion that this is the correct disposition of the new Javan genus.

ILLUSTRATION

PLATE I. *Koordersiochloa javanica* Merrill. Koorders et Mangoendimedjo delin. *A*, from life; *B* to *N*, from herbarium material *Koorders 40846 β*.

A. Habit sketch of a flowering plant.
B. Part of a flowering and fruiting plant.
C. Spikelet in flower.
D. Flower.
E. Stamen.
F. Pollen grain.
G. Gynaecium.
H. Fruiting glume and palea, the former with an awn.
J. Apex of a flowering glume.
K. Palea.
L. Caryopsis.
M. Apex of a caryopsis with the thickened base of the style.
N. Starch grains.

PLATE I. KOORDERSIOCHLOA JAVANICA MERR.

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THE MOSSES OF AMBOINA

By V. F. BROTHERUS
(*Helsingfors, Finland*)

Sometime before the late Doctor C. B. Robinson started on his botanical excursion to Amboina he requested me to take over the examination of the bryological material that he hoped to be able to collect there. I consented to his proposal in view of the fact that the bryological flora of Amboina was practically unknown, and further because I had learned, from previous collections sent to me from the Bureau of Science, that Doctor Robinson was a very able collector. The hope that rich bryological collections from Amboina might be secured has not fully been realized, as this young explorer was murdered by the natives before he had completed his work of exploration. Thanks to Mr. Merrill's kindness I have had an opportunity of examining the collection of mosses that he left, and have prepared the following report. I have included in the list those species secured in Amboina by earlier collectors, such as Zippel, Naumann, DeVriese, and Micholitz in order that the report may be more complete.[1]

FISSIDENTACEAE

FISSIDENS Hedwig

FISSIDENS ZIPPELIANUS Doz. & Molk.

AMBOINA, Batoe merah and town of Amboina, on earth and wet rocks at low altitudes, *Rel. Robins. 2284, 2285, 2287 p. p., 2304 p. p.*

FISSIDENS CRASSINERVIS Lac.

AMBOINA, Hotoe messen, *Rel. Robins. 2466*, on earth, altitude 400 meters.

[1] The statement made by me to the effect that the manuscript of this paper had been lost in transit [*This Journal* 11 (1916) *Bot.* 245, 252] was an error; the statement applies to another manuscript on Philippine mosses. [E. D. M.]

LEUCOBRYACEAE

LEUCOBRYUM Hampe

LEUCOBRYUM ADUNCUM Doz. & Molk.

AMBOINA, Hitoe messen, *Rel. Robins. 2268*, on dead wood, altitude 350 meters.

LEUCOBRYUM SANCTUM Hamp.

AMBOINA, Hitoe messen, *Rel. Robins. 2328*, on dead wood, altitude 250 meters.

LEUCOBRYUM SERICEUM Broth.

AMBOINA, Salahoetoe, *Rel. Robins. 2267*, on ground and about the bases of trees, altitude 150 meters.

LEUCOPHANES Bridel

LEUCOPHANES OCTOBLEPHARIOIDES Broth.

AMBOINA, *Zippel.*

LEUCOPHANES CANDIDUM (Hornsch.) Lindb.

AMBOINA, near the town of Amboina, *Rel. Robins. 2276*, terrestrial; *Zippel.*

OCTOBLEPHARUM Hedwig

OCTOBLEPHARUM ALBIDUM (Linn.) Hedw.

AMBOINA, Wakal and town of Amboina, *Rel. Robins. 2275, 2282*, on sago palms and on *Sonneratia* at sea level.

CALYMPERACEAE

SYRRHOPODON Schwaegrichen

SYRRHOPODON BORNEENSIS (Hamp.) Jaeg.

AMBOINA, Wakal, *Rel. Robins. 2270*, on *Sonneratia* along the seashore.

SYRRHOPODON ALBOVAGINATUS Schwaegr.

AMBOINA, Hitoe messen, *Rel. Robins. 2307, 2328 p. p.*, on dead wood, altitude 350 meters.

SYRRHOPODON CILIATUS (Hook.) Schwaegr.

AMBOINA, Roemah tiga and town of Amboina, *Rel. Robins. 2271, 2273, 2277, 2290*, on the trunks of sago palms and on trees at low altitudes.

SYRRHOPODON CROCEUS Mitt.

AMBOINA, Hitoe messen, *Rel. Robins. 2308 p. p.*, on trees, altitude 250 meters.

SYRRHOPODON MÜLLERI (Doz. & Molk.) Lac.

AMBOINA, Hitoe messen, *Rel. Robins. 2315, 2327*, on trees, altitude 350 meters.

SYRRHOPODON MANII C. Müll.

AMBOINA, Roemah tiga, *Rel. Robins. 2278*, on trees, altitude 3 meters.

SYRRHOPODON FASCICULATUS Hook. & Grev.

AMBOINA, Batoe gadjah, *Rel. Robins. 2312*, on trees, altitude 200 meters; *Zippel.*

CALYMPERES Swartz

CALYMPERES PUNGENS C. Müll.

AMBOINA, *Naumann.*

CALYMPERES SEMIMARGINATUM C. Müll.

AMBOINA, *Naumann.*

CALYMPERES PANDANI C. Müll.

AMBOINA, *Naumann.*

POTTIACEAE

BARBULA Hedwig

BARBULA COMOSA Doz. & Molk.

AMBOINA, *Zippel.*

BARBULA ORIENTALIS (Willd.) Broth.

AMBOINA, town of Amboina, *Rel. Robins. 2288, 2320*, on earth and rocks at low altitudes.

HYOPHILA Hampe

HYOPHILA COMMUTATA Broth.

AMBOINA, *Zippel.*

GYMNOSTOMIELLA Fleischer

GYMNOSTOMIELLA VERNICOSA (Hook.) Fleisch.

AMBOINA, *Micholitz.*

ORTHOTRICHACEAE

DESMOTHECA Lindberg

DESMOTHECA APICULATA (Doz. & Molk.) Lindb.

AMBOINA, *Zippel.*

MACROMITRIUM Bridel

MACROMITRIUM ANGUSTIFOLIUM Bryol. jav.

AMBOINA, Roemah tiga, *Rel. Robins. 2294, 2296*, on trees at low altitudes; *Zippel.*

BRACHYMENIUM Schwaegrichen

BRACHYMENIUM INDICUM (Doz. & Molk.) Bryol. jav.

AMBOINA, *Zippel.*

BRYUM (Dill.) Schimper

BRYUM CORONATUM Schwaegr.

AMBOINA, *Zippel.*

MYURIACEAE

MYURIUM Schimper

MYURIUM RUFESCENS (Reinw. & Hornsch.) Fleisch.

AMBOINA, *Zippel.*

ENDOTRICHELLA C. Müller

ENDOTRICHELLA ALARIS Broth. sp. nov.

Dioica; robustiuscula, lutescens, sericeo-nitens; *caules secundarii* usque ad 10 cm longi, flexuosi vel arcuato-adscendentes, dense foliosi, simplices; *folia* sicca erecto-patentia, humida patentia, conformia, mollia, pluries plicata, oblonga, sensim lanceolato-subulata, marginibus inferne anguste recurvis, integris, apice tantum minute et parce serrulatis, enervia, cellulis valde inter se porosis, anguste prosenchymaticis, basilaribus infimis brevioribus, aureis, alaribus numerosis, quadratis, fusco-aureis; *bracteae perichaetii* internae eretae, sensim lanceolato-subulatae, subintegrae, *seta* ca. 1.8 mm alta, lutescenti-rubra, laevis; *theca* erecta, breviter oblonga, fuscidula, laevis. Caetera ignota.

AMBOINA, Salahoetoe, *Rel. Robins. 2298,* epiphytica, alt. 700 m.

Species *E. eleganti* (Doz. & Molk.) Fleisch. habitu sat similis, sed foliorum structura longe diversa.

ENDOTRICHELLA ROBINSONII Broth. sp. nov.

Dioica; gracilescens, pallide lutescenti-viridis, nitidiuscula; *caulis primarius* brevis, fusco-tomentosus; *caules secundarii* numerosi, usque ad 6 cm longi, dense et complanate foliosi, simplices; *folia* sicca et humida erecto-patentia, stricta, elongate lanceolato-ligulata, breviter acuminata, acuta, profunde plicata, marginibus anguste et indistincte recurvis, apice minute serrulatis, enervia, cellulis anguste prosenchymaticis, basilaribus infimis abbreviatis, laxis, fusco-aureis, alaribus haud diversis; *bracteae perichaetii* internae erectae, minutae, abrupte apiculatae vel obtusae, apice pluries incisae; *seta* ca. 1.8 mm, lutescenti-rubra, laevis; *theca* erecta, minuta, oblonga, fusca, laevis. Caetera ignota.

AMBOINA, Hitoe messen, *Rel. Robins. 2309,* alt. 350 m.

Species E. compressae (Mitt.) Broth., mihi e descriptione tantum cognitae, valde affinis.

AËROBRYOPSIS Fleischer

AËROBRYOPSIS LONGISSIMA (Doz. & Molk.) Fleisch.

AMBOINA, Hitoe messen, *Rel. Robins. 2308,* altitude 250 meters.

AËROBRYUM Dozy and Molkenboer

AËROBRYUM SPECIOSUM Doz. & Molk.

AMBOINA, *Zippel.*

NECKEROPSIS Reichardt

NECKEROPSIS GRACILENTA (Bryol. jav.) Fleisch.

AMBOINA, Hitoe lama, *Rel. Robins. 2329*, on trees, altitude 150 meters.

HOMALIODENDRON Fleischer

HOMALIODENDRON SCALPELLIFOLIUM (Mitt.) Fleisch.

AMBOINA, *DeVriese.*

THAMNIUM Schimper

THAMNIUM ELLIPTICUM (Bryol. jav.) Kindb.

AMBOINA, Salahoetoe, *Rel. Robins. 2297*, on wet rocks, altitude 250 meters.

HOOKERIACEAE

CALLICOSTELLA (C. Müll.) Mitten

CALLICOSTELLA BECCARIANA (Hamp.) Jaeg.

AMBOINA, Soja, *Rel. Robins. 2295*, on rocks, altitude 400 meters.

CHAETOMITRIUM Dozy and Molkenboer

CHAETOMITRIUM TORQUESCENS Bryol. jav.

AMBOINA, Hitoe messen, *Rel. Robins. 2293, 2300*, on living and dead branches, altitude about 150 meters.

HYPOPTERYGIACEAE

HYPOPTERYGIUM Bridel

HYPOPTERYGIUM VRIESII Bryol. jav.

AMBOINA, Halong, *Rel. Robins. 2332*, on rocks at low altitudes.

LESKEACEAE

PSEUDOLESKEOPSIS Brotherus

PSEUDOLESKEOPSIS ZIPPELLI (Doz. & Molk.) Broth.

AMBOINA, *Zippel.*

PELEKIUM Mitten

PELEKIUM VELATUM Mitt.

AMBOINA, Soja, *Rel. Robins. 2303*, on rocks, altitude 400 meters; *Naumann* (*P. fissicalyx* C. Müll.).

THUIDIUM Bryol. eur.

THUIDIUM BIFARIUM Bryol. jav.

AMBOINA, Halong, *Rel. Robins. 2306*, on rocks, altitude 30 meters.

THUIDIUM GLAUCINOIDES Broth.

AMBOINA, Salahoetoe, *Rel. Robins. 2313*, on rocks, altitude 250 meters.

THUIDIUM CYMBIFOLIUM (Doz. & Molk.) Bryol. jav.

AMBOINA, *Zippel.*

THUIDIUM PLUMULOSUM (Doz. & Molk.) Bryol. jav.

AMBOINA, Hitoe lama, *Rel. Robins. 2328*, on limestone, altitude 150 meters; *Webb.*

HYPNACEAE

MACROTHAMNIUM Fleischer

MACROTHAMNIUM MACROCARPUM (Reinw. & Hornsch.) Fleisch.

AMBOINA, *Zippel.*

ECTROPOTHECIUM Mitten

ECTROPOTHECIUM VERRUCOSUM (Hamp.) Jaeg.

AMBOINA, town of Amboina, *Rel. Robins. 2321, 2336,* on sandstone and limestone at low altitudes.

ECTROPOTHECIUM ZOLLINGERI (C. Müll.) Jaeg.

AMBOINA, *Zippel;* Hitoe lama, *Rel. Robins. 2335,* on rocks, altitude 75 meters.

ECTROPOTHECIUM MANII Broth.

AMBOINA, Roemah tiga, *Rel. Robins. 2335,* on trees at low altitudes.

ECTROPOTHECIUM ICHNOTOCLADUM (C. Müll.) Jaeg.

AMBOINA, *Zippel.*

ECTROPOTHECIUM BUITENZORGII (Bel.) Jaeg.

AMBOINA, *Zippel.*

TRISMEGISTIA (C. Müll.) Brotherus

TRISMEGISTIA LANCIFOLIA (Harv.) Broth.

AMBOINA, Salahoetoe, *Rel. Robins. 2280,* terrestrial, altitude 150 meters.

ISOPTERYGIUM Mitten

ISOPTERYGIUM AQUIFOLIUM (Bryol. jav.) Jaeg.

AMBOINA, *DeVriese.*

VESICULARIA (C. Müll.) C. Müller

VESICULARIA MONTAGNEI (Bel.) Broth.

AMBOINA, *Zippel.*

VESICULARIA DUBYANA (C. Müll.) Broth.

AMBOINA, *Zippel;* town of Amboina, *Rel. Robins. 2304 p. p., 2318,* on earth at low altitudes.

VESICULARIA AMBOINENSIS Broth. sp. nov.

Autoica; robustiuscula, caespitosa, caespitibus densis, mollibus, sordide fuscescenti-viridibus, opacis; *caulis* elongatus, laxe foliosus, pinnatim ramosus, ramis patulis, usque ad 3 cm longis, valde complanatis, laxiuscule foliosis, simplicibus vel parce ramulosis, obtusis; *folia caulina* lateralia sicca contracta, humida patula, concaviuscula, ovata, subulato-acuminata, integra, enervia, cellulis elongate rhomboideo-hexagonis (ca. 5.1), teneris; *folia ramea* minora, brevius acuminata, laxius areolata. Caetera ignota.

AMBOINA, Halong, *Rel. Robins. 2301*, on rocks in swift water, mostly submerged, altitude 40 meters.

Species *V. scaturiginum* (Brid.) Broth. valde affinis.

TAXITHELIUM Spruce

TAXITHELIUM NEPALENSE (Schwaegr.) Broth.

AMBOINA, *Zippel;* town of Amboina, *Rel. Robins, 2272, 2311*, on bases of tree trunks at low altitudes.

TAXITHELIUM TURGIDELLUM (C. Müll.) Par.

AMBOINA, *Naumann.*

ECTROPOTHECIELLA Fleischer

ECTROPOTHECIELLA DISTICHOPHYLLA (Hamp.) Fleisch.

AMBOINA, Hitoe lama, *Rel. Robins. 2274*, on limestone, altitude 75 meters.

LEUCOMIACEAE

LEUCOMIUM Mitten

LEUCOMIUM ANEURODICTYON (C. Müll.) Jaeg.

AMBOINA, Salahoetoe, *Rel. Robins. 2334*, altitude 250 meters.

SEMATOPHYLLACEAE

TRICHOSTELEUM (Mitt.) Jaeger

TRICHOSTELEUM HAMATUM (Doz. & Molk.) Jaeg.

AMBOINA, Roemah tiga and Hitoe messen, *Rel. Robins. 2283, 2314, 2319*, on trees, sea level to 350 meters altitude.

SEMATOPHYLLUM (Mitt.) Jaeger

SEMATOPHYLLUM HYALINUM (Reinw.) Jaeg.

AMBOINA, Salahoetoe, *Rel. Robins. 2269, 2279*, on trees, altitude 700 to 800 meters.

SEMATOPHYLLUM WARBURGII Broth.

AMBOINA, Salahoetoe, *Rel. Robins. 2310*, on trees, altitude 850 meters.

RHACOPILACEAE

RHACOPILUM Palisot de Beauvois

RHACOPILUM AMBOINENSE Broth. sp. nov.

Dioicum; robustiusculum, caespitosum, caespitibus densis, depressis, viridibus, opacis; *caulis* longe prostratus, fusco-tomentosus, dense foliosus, pinnatim ramosus, ramis patulis, vix ultra 1 cm longis, cum foliis ca. 2.5 mm latis, curvatis, simplicibus, obtusis; *folia* sicca sursum curvata, humida planissima, breviter oblonga, obtusa, aristata, marginibus erectis, superne inaequaliter serrulatis, nervo tenui, in aristam brevem excedente, cellulis subrotundato-hexagonis, pellucidis, ca. 0.02 mm, mar-

ginem versus minoribus, basilaribus internis laxioribus, breviter oblongis, plus minusve alte secus nervum productis, omnibus laevissimis; *folia antica* multo minore, cordato-lanceolata, aristata, superne inaequaliter serrulata. Caetera ignota.

AMBOINA, Hitoe messen and Hitoe lama, *Rel. Robins. 2286, 2299,* on limestone, altitude 150 meters.

Species *Rh. spectabili* Reinw. & Hornsch. affinis, sed statura minore, foliis posticis oblongis, obtusis, minutius serrulatis, nervo tenuiore, brevius excedente dignoscenda.

POLYTRICHACEAE

POGONATUM Palisot de Beauvois

POGONATUM CIRRATUM (Sw.) Brid.

AMBOINA, *DeVriese.*

POGONATUM TEYSMANNIANUM (Doz. & Molk.) Bryol. jav.

AMBOINA, Soja, *Rel. Robins. 2316,* on banks, altitude 450 meters.

RHACELOPUS Dozy and Molkenboer

RHACELOPUS PILIFER Doz. & Molk.

AMBOINA, Hoetoemoeri road, *Rel. Robins. 2281,* on earth and stones, altitude 200 meters.

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A NEW SPECIES OF CALAMUS FROM AMBOINA

By O. BECCARI
(*Florence, Italy*)

CALAMUS ROBINSONIANUS Becc. sp. nov.

Scandens, gracilis, caudice vaginato 15 mm diam., vaginis (non flagelliferi?) spinis acicularibus armatis. Folia cirrifera, regulariter pinnata, parte petiolari brevi, complanata, aculeolata; segmentis numerosis, aequidistantibus concinnis, angustissime lanceolatis, majoribus 18 ad 22 cm longis, 10 ad 14 mm latis, apice subtilissime acuminatis, unicostulatis, utrinque in costa media setosis, nervis lateralibus tenuibus nudis; marginibus remotissime et appresse spinulosis vel fere laevibus. Spadices ♂ et ♀ similes, foliis multo breviores (±25 cm longi), furfure fusca adspersi, parte pedicellari propria destituti, complanati, paniculati, erecto-patuli; inflorescentiis partialibus bifarie divaricatis, disticis, simpliciter ramosis; spathis primariis brevibus, complanatis, anguste infundibuliformibus; spatha basilari subancipiti, pedicelliformi, 3 cm longa, in ore ciliata et exacte truncata; spathis superioribus sensim paullo minoribus, oblique truncatis, acutis vel acuminatis. Flores masculi curvuli, oblongi, obtusi, 5 mm longi. Spicae foemineae majores 4 cm longae, floribus disticis, utrinque 6 vel 7; spathellis brevibus breviter tubulosis in ore ampliatis; involucrophoris brevisime elevatis, subpedicelliformibus; involucris orbicularibus, discoideis. Fructus anguste elliptici, 1 cm longi, 5 mm lati, utrinque attenuati, conice rostratis; squamis per orthostichas 12 ordinatis, convexis leviter in medio sulcatis, stramineis, margine conspicue atropurpureo.

AMBOINA, Mount Salahoetoe (Salahutu), *Reliquiae Robinsonianae 1612* (♂ plant), *1613* (♀ plant), November 27, 1913, altitude 850 meters. Native name *rotang tuni*.

A very distinct species, referable to group XV of my monograph on account of its cirriferous leaves and non-flagelliferous leaf-sheaths; but in that group it has no affinities. It is particularly distinguishable by its spadices being considerably shorter than the leaves, and resembling those of a *Daemonorops*, but furnished with only short, infundibuliform, closely sheathing, primary spathes.

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A NEW SPECIES OF GUIOA FROM AMBOINA

By L. RADLKOFER
(*Munich, Germany*)

GUIOA Cavanilles

GUIOA MULTIPUNCTATA Radlk. sp. nov.

Arbor 5 m alta; rami teretes, glabri, cortice laevi rubro-fusco; folia abrupte pinnata; foliola alterna, sat approximata, oblongo-lanceolata, acuminata, basi inaequilatera (latere exteriore angustiore), petiolulis conspicuis fere ab apice sensim incrassatis rugosis suffulta, integerrima, chartacea, nervis procurvis arcuato-anastomosantibus, glabra nec nisi pilis microscopicis subulatis patentibus supra laxe adspersa, epapillosa, supra subfusca, subtus pallida, cellulis secretoriis crebris permagnis per staurenchyma, nec non sat magnis utriculiformibus per pneumatenchyma persita, inde dense grossiuscule pellucido-punctata, insuper insignia epidermide paginae superioris sparsim crystallophora, plurifoveolata, foveolis sat amplis; rhachis nuda, teretiuscula; paniculae axillares, parvae, petiolos vix duplo superantes, glabrae; discus sub fructu relictus annularis, aequalis, glaber; capsula inter minores, obcordato-triloba, breviter stipitata, styli reliquiis apiculata, lobis seminigeris ellipsoideis patentibus, 1 vel 2 interdum inanibus multo minoribus lateraliter compressis, glabra, aqua agitata spumam efficiens, endocarpio sclerenchymatico secus medianam interrupto laevi; semen ellipsoideum, totum arillo carnoso basi processu filiformi appendiculato obvolutum.

Rami 6 mm crassi. Folia petiolo 2 cm longo adjecto 18 ad 22 cm longa; foliola cum petiolulis 5 ad 7 mm longis 8.5 ad 14.5 cm longa, 2.5 ad 4 cm lata. Paniculae 3.5 cm longae. Capsula 8 mm alta, stipite vix 3 mm longo, 1.3 cm lata. Semen 6 mm longum, diametro 4 mm.

AMBOINA, Gelala, *Reliquiae Robinsonianae 1602*, September 19, 1913, altitude 125 meters, comm. ex Hb. Manil.

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THE RELATION BETWEEN LIGHT INTENSITY AND CARBON DIOXIDE ASSIMILATION

By WILLIAM H. BROWN and GEORGE W. HEISE

(From the College of Liberal Arts, University of the Philippines, and from the Bureau of Science, Manila, P. I.)

In the absence of complicating factors there is, with many photochemical reactions, a direct proportionality between light intensity and reaction velocity. This relationship was first postulated by Malaguti(13) and afterward experimentally substantiated by Draper.(7) It is expressed in the well-known law of Bunsen and Roscoe,(5) as follows:

$$E=kit,$$

where E is the photochemical effect, i the intensity factor, t the time factor, and k a constant.

Reactions free from complicating factors are by no means easy to find. Even with comparatively simple photochemical processes, in which all factors can be controlled with some degree of certainty, complications frequently arise which cause deviations from the Bunsen and Roscoe law. This is well illustrated by the difficulty encountered in securing reactions suitable for actinometric work. With long-continued reactions, high light intensities, or great changes in light intensity(22) the reaction velocity is often less than strict proportionality would require. This discrepancy between cause and effect has been determined experimentally by a number of workers, including Luther and Weigert,(12) and has been calculated by Byk.(6)

It has been determined that a simple relationship does not hold in the much-studied case of the exposure of the photographic plate.(22) For certain light intensities the photochemical effect produced S is proportional, not to the intensity I, but to the logarithm of the intensity, in accordance with the equation

$$S=k \log i.$$

For another intensity range the relationship is expressed by an even more complicated formula, namely:

$$S=\Upsilon \log (it+C).$$

There are progressively greater deviations from the Bunsen-Roscoe law with still higher light intensities. The augmentation of photographic effect proceeds more and more slowly until there is no further increase, when a certain limiting light intensity is reached.

The photosynthetic assimilation of carbon dioxide by plants is a complicated reaction affected by many factors; hence there is a priori no reason to expect that the relationship between assimilation and light intensity under natural conditions should be expressed as a simple, direct proportionality. The general statements [1] in the literature, however, give the impression that the amount of carbon dioxide assimilation in plants is directly proportional to the intensity of the incident light. The writers have recently had occasion to review the literature on photosynthesis, and believe it worth while to call attention to the fact that these statements by no means express the conclusions to be

[1] Pfeffer(17) says:

The photosynthetic activity increases proportionately to the intensity of the light, as has been repeatedly shown since the first experiments by Wolkoff. There is, however, a limit to the increase.

Further on, the foregoing statement is somewhat amended as follows:

No mathematically exact relation can be expected between the photosynthetic activity and the intensity of the light, for as the light increases other influences may be exerted, which directly or indirectly modify the assimilatory powers of the chloroplastids.

According to Jost(10):

As the light increases in intensity, CO_2-assimilation also increases. When the light is about as intense as ordinary sunlight, however, this relation is not maintained, and this for several reasons.

Barnes(1) writes:

From the point at which the effective energy of the light absorbed is just equal to disposing of the available CO_2, whether this is greater than natural or not, lessening the intensity of the light results in a proportional diminution of the amount of the product.

Blackman and Matthaei(2) make the following statement:

The general views expressed in this paper involve the assumption that *with all intensities of light the amount of assimilation is proportional to the intensity of the light* unless some secondary or limiting factor is at work.

Blackman and Smith(3) in their work on *Elodea* determined two points on a curve representing the relation between carbon dioxide assimilation and light intensity and then drew the curve as a straight line.

Jorgensen and Stiles(9) in an extensive review of the recent literature on carbon dioxide assimilation also hold that assimilation is directly proportional to light intensity.

derived from the available experimental data. If the photochemical process in carbon dioxide assimilation could be studied independently of all complicating reactions it might well show a direct proportionality between light intensity and reaction velocity, but the experimental evidence at hand does not prove that such a relation holds for photosynthesis as it takes place under natural conditions.

One of the most extensive investigations on the relation of carbon dioxide assimilation to light intensity is that of Reinke, who worked with *Elodea.*(18) In Table I we have summarized Reinke's Table VIII, using the average of all his values for assimilation with any given intensity of light. This is Reinke's longest and probably his most important experiment.

TABLE I.—*Summary of Reinke's Table VIII, showing the relation between light intensity and bubble emission.*

Light intensity.		First series. Number of bubbles.			Second series. Number of bubbles.		
Full sunlight—1.	$\frac{1}{16}$ sunlight=1.	In 15 seconds.	Increase per added unit of $\frac{1}{16}$ sunlight.	Average per unit of light.	In 15 seconds.	Increase per added unit of $\frac{1}{16}$ sunlight.	Average per unit of light.
$\frac{1}{16}$	1	5.5	5.5	5.5			
$\frac{1}{8}$	2	7.5	2.0	3.7			
$\frac{1}{4}$	4	11.0	1.7	2.7	8.7	2.2	2.2
$\frac{1}{2}$	8	18.5	1.9	2.3	15.0	1.6	1.9
1	16	27.0	1.1	1.7	23.2	1.0	1.4
2	32	35.0	0.5	1.1	29.7	0.4	0.9
4	64	39.0	0.1	0.6	30.2	0.02	0.5
8	128	38.2	0.0	0.3	31.5	0.02	0.2
16	256	39.0	0.0	0.1	31.5	0.0	0.1

Obviously the foregoing data show no simple direct proportionality between assimilation and light. Instead there is for each increase in light intensity a progressively smaller increase in the assimilation velocity. This progressive falling off in assimilation per unit of increase in light is very rapid, and it is, therefore, not surprising that with high light intensities increasing the intensity does not greatly augment the rate of assimilation.

In Table II we have calculated the increase in bubble emission per unit of light for Reinke's different tables. These results are in agreement with the more detailed calculations given in Table I for Reinke's Table VIII.

TABLE II.—*Augmentation in the rate of carbon dioxide assimilation per unit of light increase as shown by Reinke's tables.*

[Numbers represent increase in number of bubbles emitted.]

Light in units of ⅛ sunlight.	Reinke's table number.								
	1	2	3	4	5	6	7	8	
								First series.	Second series.
1	4.0	9.0						5.5	
2	5.7	6.0	2.8			5.5		2.0	
4	5.4	4.0	5.1	0.9	1.0	8.6	0.7	1.7	2.2
8		3.2	4.4	1.6	1.9	2.9	0.5	1.9	1.6
16	1.5	0.5	0.9	1.2	1.2	2.5	0.2	1.1	1.0
32	0.0		0.0	0.8	0.6		0.1	0.5	0.4
64	0.0		0.0	0.2	0.2		0.0	0.1	0.0
128	0.0		0.0	0.0	0.0		0.0	0.0	0.0
256				0.0	0.0		0.0	0.0	0.0

It is to be noted that with very low light intensities Reinke frequently found that doubling the light intensity resulted in more than doubling the number of bubbles given off by *Elodea*. This result was probably due in part to the failure in the bubble-counting method to make correction for respiration. Other sources of error with low light intensities have been discussed by Reinke himself and by Pantanelli.(16) It would seem evident therefore that the results obtained with small ranges of low intensities cannot be regarded as expressing adequately the relation between carbon dioxide assimilation and light intensity and that, if a direct proportionality between light intensity and assimilation is found in such a case, this is due to the selection of a particular range of light intensities.

Reinke's interpretation of his results is as follows:

Die von Lichte abhängige Gasausscheidung (von Elodea) beginnt bei mittlerer Beleuchtungsstärke und steigert sich gleichsinnig mit der wachsenden Lichtintensität bis zu einem Maximum (Optimum), welches ungefähr dem directen Sonnenlicht entspricht, bald bei etwas geringerer, bald erst bei etwas höherer Intensität erreicht wird; jede weitere Vermehrung der Lichtintensität hat keine weitere Beschleunigung der Gasblasenausscheidung zur Folge.

* * * * * * *

Wenn Wolkoff im Allgemeinen eine Proportionalität zwischen Lichtintensität und Sauerstoffausscheidung beobachtet zu haben glaubt, so steht dies Ergebniss im guten Einklang mit den von mir über den Einfluss der mittleren Lichtintensitäten gemachten Beobachtungen; bei einer weiteren Verstärkung des Lichtes tritt dann eine Aenderung der für mittlere Intensitäten gültigen Curve ein, wobei der Effect des Lichtzuwachses sich verringert und endlich auf Null sinkt; bei niederen Lichintensitäten muss

eine angenäherte Proportionalität zwischen Lichtstärke und der ausgeschiedenen Sauerstoffmenge durch die Athmung in ähnlichem Sinne beseitigt werden.

One of the most widely quoted researches on photosynthesis is that of Pantanelli,(16) who also worked on *Elodea* with a bubble-counting method.

Pantanelli's results on this subject are perhaps best expressed in his figure *a*, obtained with a carbon dioxide concentration of 1 to 15 volume per cent. We have shown in Table III all the readings given by him in curve *a* for assimilation velocities with different light intensities up to full sunlight. In order to make Pantanelli's results comparable with those of other workers, we have reduced his readings from the number of seconds required for the evolution of ten bubbles to the number of bubbles evolved in ten seconds.

TABLE III.—*Carbon dioxide assimilation and light intensity (Pantanelli on Elodea).*

[Curve (*a*) 1–15 volume per cent CO_2.]

Series.	Light intensity (direct sunlight=1).		Initial value.			After ten minutes exposure.		
	Fraction.	Decimal.	Time required for 10 bubbles.	Number of bubbles in 10 seconds.	Increase in number of bubbles per unit of 0.01 direct sunlight.	Time required for 10 bubbles.	Number of bubbles in 10 seconds.	Increase in number of bubbles per unit of 0.01 direct sunlight.
			Seconds.			*Seconds.*		
I. Ascending	1/36	0.028	33.2	3.05	1.09	35.3	2.83	1.01
	1/25	0.040	21.0	4.76	1.40	22.0	4.55	1.41
	1/15	0.066	15.0	6.66	0.71	16.0	6.25	0.63
	1/9	0.111	12.3	8.13	0.33	13.3	7.60	0.30
	1/4	0.250	9.67	10.47	0.16	----------	(?)	----------
	1/1	1.000	7.7	13.0	0.03	8.5	11.8	0.01
II. Descending	1/36	0.028	35.3	2.83	1.01	33.2	3.05	1.09
	1/25	0.040	26.0	3.85	0.83	24.7	4.05	0.82
	1/15	0.066	19.3	5.2	0.50	18.0	5.55	0.56
	1/9	0.111	15.1	6.6	0.31	13.9	7.2	0.37
	1/4	0.250	8.5	11.8	0.37	----------	----------	----------
	1/1	1.000	7.07	14.3	0.03	----------	----------	----------

As in Reinke's work,(18) the first augmentation of the rate of bubble emission is in some cases proportionately greater than that of light. Again the results show not a direct proportionality between assimilation and light intensity, but a progressively smaller relative increase in assimilation with increasing illumination.

In fig. 1 we have shown this relation graphically by plotting on plain coördinate paper the results given in Table III for light intensities up to full sunlight. The initial values and the values after 10-minute exposure are plotted separately for both the ascending and descending series.

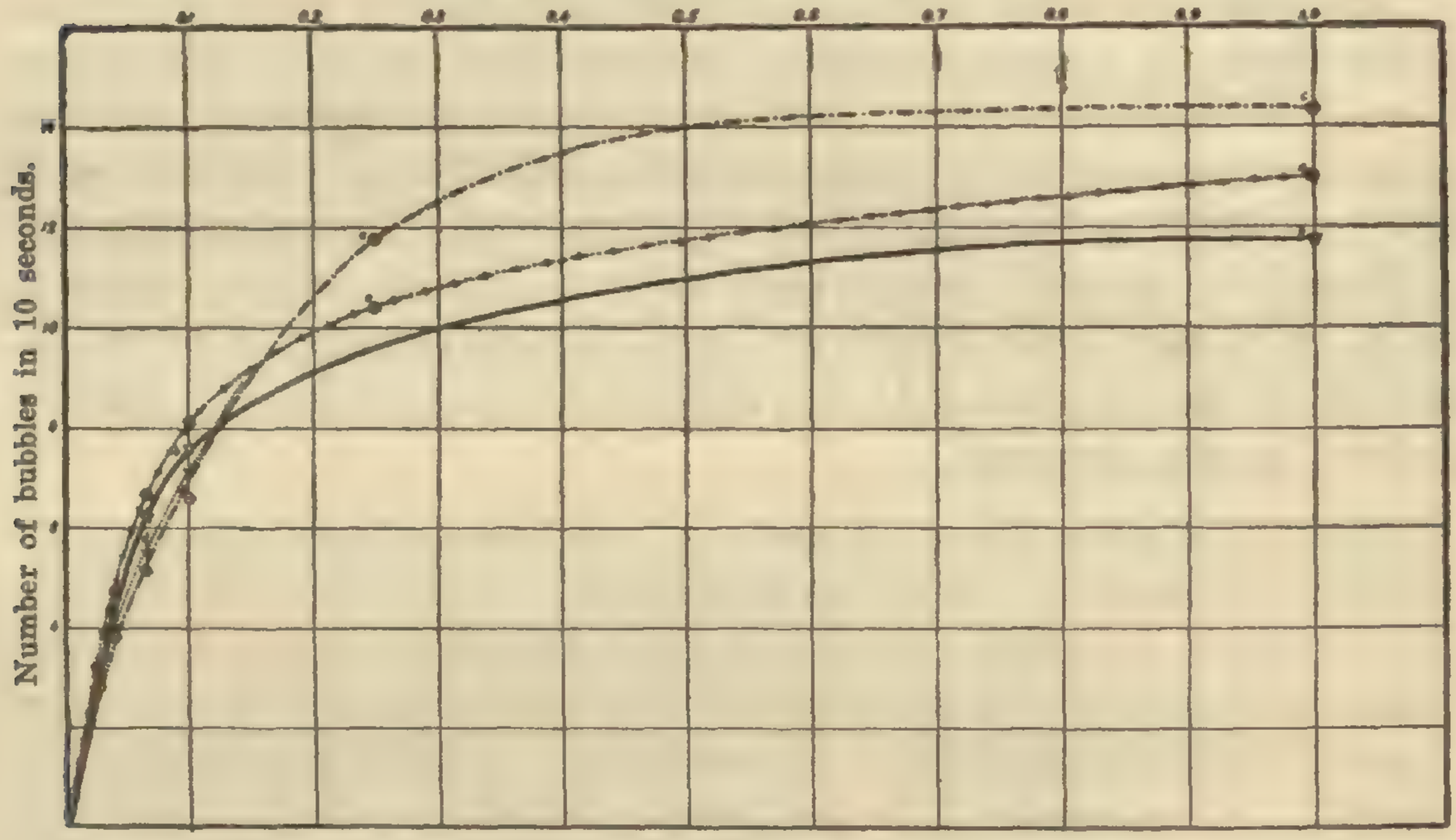

FIG. 1. Relation between light intensity and bubble emission in *Elodea*. Results obtained with carbon dioxide concentrations of 1 to 15 volume per cent. From Pantanelli, Table IV, curve *a*. Curve *a* is for the initial values in the ascending series; *b*, for values after 10-minute exposure in the ascending series; *c*, for initial values in the descending series; *d*, values after 10-minute exposure in the descending series.

It is clear that the general form of the curve would be the same, whether any one series or the average for all series were considered. There is no apparent reason for expressing the relationship as a straight line, as would be the case if the assimilation were directly proportional to light intensity.

Pantanelli himself does not clearly state his opinion concerning the validity of a direct proportionality, but in his discussion of the results of previous workers he apparently assumes that such a proportionality does exist.

In their analysis of Pantanelli's work Blackman and Smith,(3) by using a small horizontal scale and drawing their curve in an arbitrary manner, obtain a straight line for lower light intensities, and from this they conclude that

> From intensity $\frac{1}{36}$ to $\frac{1}{4}$ [sunlight] the assimilation increases in direct proportion with the increase of light and then a limit is reached.

The fallacy of this reasoning is apparent from the form of the curve in fig. 1. As there is no indication that a limit of assimila-

tion is reached at ¼ sunlight, there is no real justification for so abrupt a change in slope as is indicated in the curve given by Blackman and Smith.

These writers(3) take exception to the work of Pantanelli, because of the possible effect of temperature as a disturbing factor, as his work was carried out before Miss Matthaei had caused the great significance of this factor to be generally recognized. In a previous paper(4) we have shown that the temperature coefficient of carbon dioxide assimilation at the temperature at which Pantanelli performed his experiments (22° C. to 30° C.) is so small that the error, if any, introduced by neglecting to keep the temperature absolutely constant may well be disregarded.

In the same paper we analyzed the results of Matthaei(14) on cherry laurel, and found that the relation between light intensity and assimilation might be expressed as a regular curve, similar in form to those of Pantanelli(16) and Reinke.(18) Matthaei's results are shown in fig. 2. The agreement with the work previously discussed is particularly interesting, as Matthaei was experimenting with a land plant and made direct measurements of the carbon dioxide assimilated.

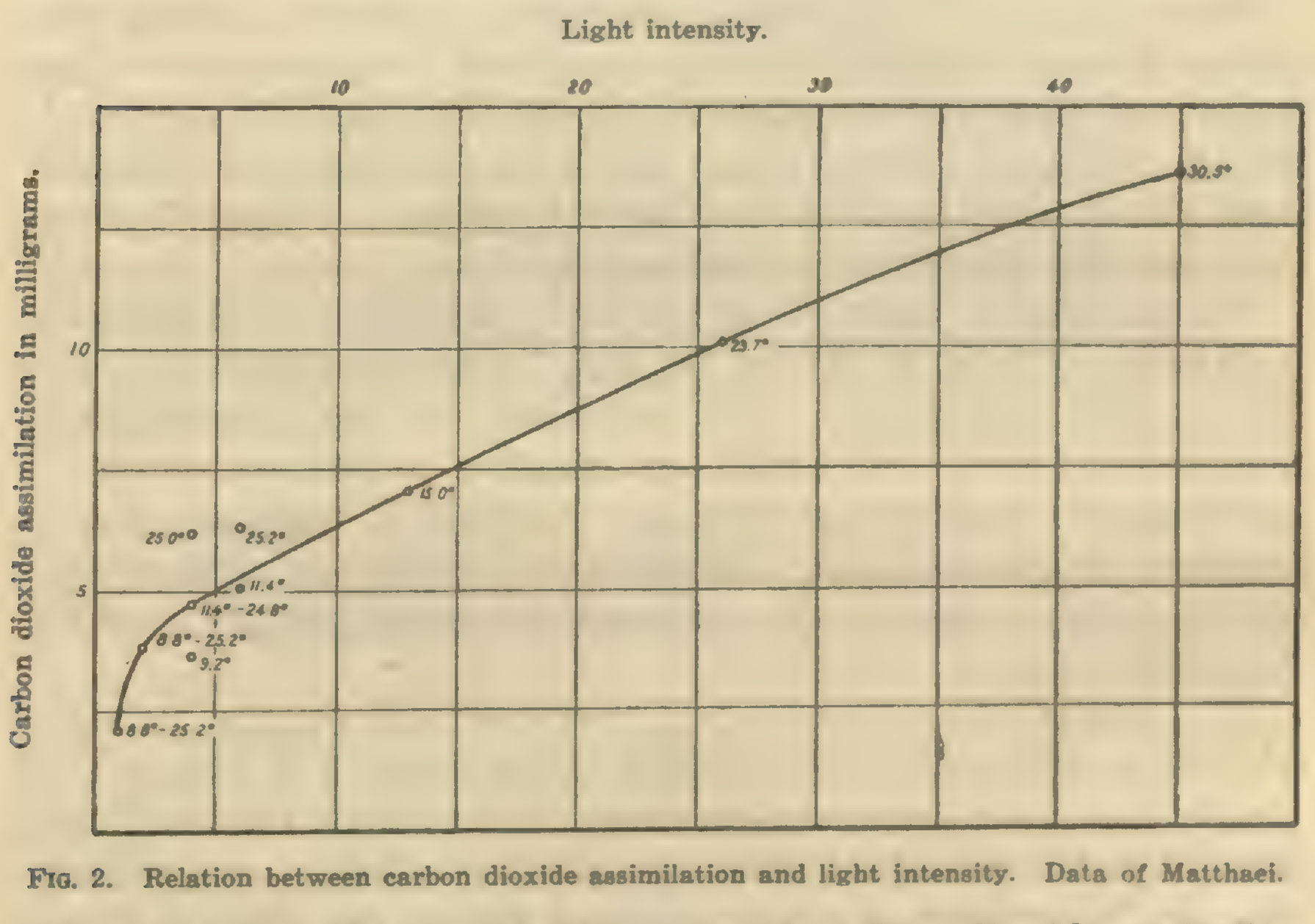

FIG. 2. Relation between carbon dioxide assimilation and light intensity. Data of Matthaei.

In reviewing the recent literature of carbon dioxide assimilation, Jorgensen and Stiles(9) lay considerable stress on the work of Blackman and Matthaei(2) as showing that there is a direct relation between carbon dioxide assimilation and various inten-

sities of natural illumination. As no measurements were made of the light intensity employed in this work, the results are qualitative and need not be considered here.

Edmond Rosé(19) has done considerable work on photosynthesis, but his interest was not primarily directed toward the study of the relationship between assimilation and light intensity, and his quantitative data are of no interest here.

The earlier work on this subject has been discussed critically by Reinke(18) and by Pantanelli,(16) who have shown conclusively that it failed to established the relation between assimilation and light. It requires, therefore little more than brief mention here.

Von Wolkoff(23) studied the effect of different light intensities on the rate at which gas bubbles were liberated from plants immersed in water containing carbon dioxide and found a very close proportionality between illumination and reaction velocity. He worked with feeble light intensities and only over a very small range. It is clear from the work of Reinke(18) and of Pantanelli(16) that the relation between bubble emission and light varies with different illumination intensities so that work over a small range cannot establish a general law.

The work of van Tieghem(21) has been quoted as showing that carbon dioxide assimilation is proportional to the incident light intensity. This author gave the results of a single experiment with a submerged water plant and concluded that the *acceleration* was proportional to the light intensity. His method of reaching this conclusion is not entirely clear.

The gasometric measurement of the assimilation of land plants with varying light by Müller(15) may be disregarded because of Pantanelli's apparently valid criticism of the experimental method employed. We have been unable to consult this work.

Reinke(18) has shown that the method of experimentation employed by Famintzin(8) is also open to objections. The results of the latter, however, do not show a proportionality between light intensity and assimilation.

The experimental results of Timiriazeff(20) on the influence of light on photosynthesis in *Potamogeton lucens* and certain land plants (species not stated) have been criticized by Pantanelli(16) because of the methods employed. Owing to faulty experimentation and the method of presentation of data in the original paper, this work has received scant attention. However, as the results show good general agreement with the works of Reinke,(18) Pantanelli,(16) and Matthaei,(14) and his interpretation is better than that of the other workers, we have summarized the results

in Table IV. In the absence of numerical data in the original paper, we have been obliged to interpolate values from the curve (p. 381) representing the mean of all his experiments. In this table the values for light intensity are given on the basis: direct insolation equals 1.0. The carbon dioxide decomposed is expressed in terms of a maximum assimilation equal to 100.

TABLE IV.—*Timiriazeff on photosynthesis.*

Light intensity (direct insolation=1).	Carbon dioxide absorbed.	Difference per 0.05 unit change in light.
0.05	20	20
0.10	38	18
0.15	56	18
0.20	67	11
0.25	76	9
0.30	84	8
0.35	89	5
0.40	93	4
0.45	95	2
0.50	97	2
0.55	98	1
0.60	99	1
0.7	100	0.5
0.7–1.0	100	0

Just as in Reinke's work(18) there is, per unit increase in light intensity, a progressively smaller augmentation of the rate of bubble emission. Timiriazeff's view of the relation between light and assimilation is expressed in the following statement:

> On voit que la décomposition de l'acide carbonique augmente d'abord rapidement, ensuite de plus en plus lentement, atteint un maximum (correspondant à ½ environ de l'insolation directe), pour devenir définitivement stationnaire.

This seems to us to be the most accurate interpretation of the published data on the relation between light intensity and carbon dioxide assimilation that we have been able to find in the literature.

An exhaustive review is beyond the scope of the present article. The papers discussed are, however, those which are the most prominent in the literature and those on which the idea of a direct proportionality between carbon dioxide assimilation and light intensity are usually based.

Unfortunately, most of the work on the relation of carbon dioxide assimilation and light intensity has been done by the bubble-counting method. An exhaustive study by Kniep(11) has

shown that this method must be used with great caution and that consequently the published data are to a large extent unreliable. For example, Kniep found that the oxygen content of the bubbles varied from 22 to 45 per cent, depending upon the intensity of the incident light. His paper makes it very clear that the number of bubbles given off by a plant on illumination is not necessarily proportional to the assimilation.

SUMMARY

The published work on photosynthesis does not warrant the generally accepted conclusion that carbon dioxide assimilation in plants is proportional to the light intensity. Instead they indicate a progressively smaller augmentation of the rate of assimilation for each increase in light intensity. This decrease in the rate of augmentation continues until a point is reached at which further increase in light produces no measurable increase in assimilation.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Relation between light intensity and bubble emission in *Elodea*. Results obtained with carbon dioxide concentrations of 1 to 15 volume per cent. From Pantanelli, Table IV, curve *a*.

2. Relation between carbon dioxide assimilation and light intensity. Data of Matthaei.

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NOTES ON THE FLORA OF KWANGTUNG PROVINCE, CHINA

By E. D. MERRILL[1]

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

Through the interest of Doctor Walter T. Swingle, of the United States Department of Agriculture, Washington, D. C., I was enabled to spend the period from October 13 to November 9, 1916, in prosecuting field work in Kwangtung Province. Thanks to the courtesy of Mr. G. Weidman Groff, of the Canton Christian College, I was granted the facilities of that institution and made this the base of my field work. All collections were made on Honam Island, across the river from Canton, with the addition of one short trip, October 27 to 30, to Loh Fau Mountain (Lofaushan) in the country to the northeast of Canton. During the period spent in China, I collected about 600 numbers in all groups, and this collection presents a number of species previously unrecorded from China, or at least from Kwangtung Province, as well as some apparently undescribed forms. The present paper consists of the descriptions of these new species, and an enumeration of the additions to the Kwangtung flora, with a few references based on other collections, notably material secured by Mr. C. O. Levine of the Canton Christian College. In a few cases, where questions of nomenclature are involved, new combinations have been made.

Hance[2] makes the following statement regarding the Kwangtung flora:

> Six years ago the writer expressed the hope that he might shortly be able to give a complete list of all the plants which had been found in the province of Kwangtung. Further consideration, and especially the circumstance that almost every short excursion from Canton or other cities where foreigners reside leads to the discovery of three or four new plants, has convinced him that such an enumeration would, after all, be too imperfect to be worth compiling; whilst the opening of several new ports, and the annually increasing facilities for penetrating into the interior of the Empire, encourage the hope that we may soon acquire a far better and more comprehensive knowledge of one of the most interesting Floras which can occupy the attention of botanists.

[1] Professor of botany, University of the Philippines.
[2] Spicilegia florae sinensis I. *Journ. Bot.* 16 (1878) 6.

Since Hance's time an enormous amount of botanical material has been collected in all parts of China, Forbes and Hemsley [3] enumerating 8,271 species for the area covered by their work. For the flora of Kwangtung Province, Dunn and Tutcher [4] have listed and made keys for about 2,550 species of flowering plants and ferns, giving the distribution, within the area, time of flowering, and color of the flowers for each species. This publication forms an excellent working basis for the flora of Kwangtung. The regions indicated by these authors on their accompanying map as botanically explored comprises but a small percentage of the entire area of the province, and these areas are chiefly in the more accessible regions. They state in their summary of desiderata that it is desirable to explore not only the unknown areas, but also indicate the necessity of an investigation of the more accessible parts. The additions to the Kwangtung flora in the present paper are all from areas that have been fairly exhaustively explored, so it is evident that intensive field work in almost any part of Kwangtung Province may be expected to yield additions to the known flora, while an exploration of the vast botanically unexplored areas will certainly yield not only additions in the nature of already described species, but may be expected to yield a fair number of undescribed forms. The material collected by me adds several hundred localities to Dunn and Tutcher's list, but it has not been considered worth while to enumerate these here.

POLYPODIACEAE

HUMATA Cavanilles

HUMATA REPENS (Linn. f.) Diels in Engl. & Prantl. Nat. Pflanzenfam. 1[4] (1899) 209.

Loh Fau Mountain (Lofaushan), *Merrill 10335*, on cliffs in damp shaded ravines, altitude about 1,000 meters.

Widely distributed in tropical and subtropical Asia, extending to the Philippines and the Mascarene Islands.

ASPLENIUM Linnaeus

ASPLENIUM PRAMORSUM Sw. Prodr. (1788) 130.

Loh Fau Mountain (Lofaushan), *Merrill 10333*, on cliffs in shaded ravines, altitude about 1,000 meters.

Widely distributed in the tropical and subtropical parts of both hemispheres.

[3] An enumeration of all the plants known from China Proper, etc. *Journ. Linn. Soc. Bot.* **23** (1886–88) 1–521; **24** (1889–1902) 1–592; **36** (1903–05) XI+1–686.

[4] Flora of Kwangtung and Hongkong (China). *Kew Bull. Add. Series* 10 (1912) 1–370.

DENNSTAEDTIA Bernhardi

DENNSTAEDTIA SCABRA (Wall.) Moore Index Filicum (1861) 307.

Loh Fau Mountain (Lofaushan), *Merrill 10246*, October 30, 1916, in damp ravines, altitude about 1,000 meters.

Widely distributed in tropical Asia, extending to the higher mountains of the Philippines; new to Kwangtung.

MONACHOSORUM Kunze

MONACHOSORUM SUBDIGITATUM (Blume) Kuhn Chaetopt. (1882) 345.

Loh Fau Mountain (Lofaushan), *Merrill 10234* (det. Copeland), October 28, 1916, in damp ravines, altitude 1,100 meters.

Widely distributed in tropical Asia and on the higher mountains of the Malay Archipelago and the Philippines; new to Kwangtung.

LEMNACEAE

WOLFFIA Horkel

WOLFFIA ARRHIZA Wimm. Fl. Schles. (1857) 140.

Honam Island, near Canton, *Merrill 10381*, locally abundant on stagnant water.

GRAMINEAE

ANDROPOGON Linnaeus

ANDROPOGON CHINENSE (Nees) comb. nov.

Homoeatherum chinense Nees in Hook. & Arn. Bot. Beechy's Voy. (1841) 239; Steud. Syn. (1854) 412.

Andropogon apricus Trin. var *chinensis* Hack. in DC. Monog. Phan. 6 (1889) 457.

Loh Fau Mountain (Lofaushan), *Merrill 10306*, on open grassy slopes, altitude about 600 meters.

The type of *Homoeatherum chinense* Nees was from Macao or its immediate vicinity, and the specimen cited above agrees closely with the description as repeated by Steudel. Hooker f.[1] considered that *Homoeatherum chinense* Nees, which Hackel included under *Andropogon apricus*, was the same as *Andropogon fastigiatus* Sw., in which disposition of it he was followed by Rendle, who, however, states that he had seen no specimen of the Chinese form. On account of its paired spikes I do not see how it can possibly be placed with Swartz's species, the only one in the subgenus *Diectomis;* and again, on account of prominently bisetose first glume of the sessile spikelet, I do not see how it can be placed under *Andropogon apricus* Trin., although I consider it to belong in the subgenus *Arthrolepis*. The pedicelled spikelets in our material are much smaller than in American specimens of *Andropogon fastigiatus* Sw. and differ from those of Swartz's species in many details.

ANDROPOGON SANGUINEUS (Retz.) comb. nov.

Rottboellia sanguinea Retz. Obs. 3 (1783) 25.

Thelepogon sanguineus Spreng. Syst. 1 (1825) 299.

Andropogon pseudograya Steud. Syn. 1 (1855) 365.

[1] Fl. Brit. Ind. 7 (1897) 170.

Loh Fau Mountain (Lofaushan), *Merrill 10191*, on open grassy slopes, altitude about 500 meters.

The oldest valid specific name for this species is here adopted. Rendle[6] enumerates this form from China as *Andropogon hirtiflorus* Kunth, following Hooker f.[7] in this identification. Hooker f. states that Dr. Stapf had identified the Indian form with the American and African ones. In any case *Rottboellia sanguinea* Retz. is the earliest name for the species.

DIGITARIA Heister

DIGITARIA VIOLASCENS Link Hort. Berol. 1 (1827) 229.

Honam Island, near Canton, *Merrill 10089*, on open sterile hillsides at low altitudes.

In this identification I follow Hackel, as the Chinese specimens conform in all particulars with Philippine material so named by him. It has perhaps been included in Chinese lists under *Digitaria longiflora* Pers.

PANICUM Linnaeus

PANICUM MYOSUROIDES R. Br. Prodr. (1810) 189.

Loh Fau Mountain (Lofaushan), *Merril 10270*, along the margins of a small pool in open grass lands near the summit, altitude about 1,250 meters.

India to tropical Africa, Malaya, and tropical Australia; not credited to China by Rendle in Forbes and Hemsley's Enumeration of Chinese plants.

PANICUM PALUDOSUM Roxb. Fl. Ind. 1 (1820) 310.

Honam Island, near Canton, *Merrill 9948*, about water holes in muddy places at about sea level.

This species has not hitherto been reported from China. Roxburgh's species has been confused by many authors with *Panicum proliferum* Lam., an American species, which Hitchcock has shown to be identical with the older *Panicum miliare* Lam. It is possible that *Panicum paludosum* Roxb. may prove to be identical with the American *Panicum dichotomiflorum* Michx.

PANICUM AURITUM Presl Rel. Haenk. 1 (1830) 305.

Honam Island, near Canton, *Merrill 9845*, about water holes, at about sea level.

India to Malaya and the Philippines, not previously reported from China.

ISACHNE R. Brown

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ISACHNE CHINENSIS sp. nov.

Culmo erecto vel basi decumbente, circiter 50 cm alto, haud ramoso, glabro, infra circiter 2 mm crasso; nodis glabris vel minutissime puberulis; vaginis quam internodiis longioribus, striatis, margine prominente ciliatis; ligulis brevissimis, ciliatis; foliis subcoriaceis, patulis, lanceolatis, 5 ad 11 cm longis, 7 ad 12

[6] Journ. Linn. Soc. Bot. 36 (1904) 373.
[7] Fl. Brit. Ind. 7 (1897) 167.

mm latis, striatis, utrinque minutissime scaberulis, apice tenuiter acuminatis, basi latis, obtusis, abrupte cordatis vel subcordatis, margine cartalagineis, scaberulis; paniculis exsertis, 13 ad 20 cm longis, laxis, ramis paucis, elongatis, solitariis, viridis vel purpureis, glabris, tenuibus, paucifloris, inferioribus 10 ad 13 cm longis, patulis vel adscendentibus; spiculis ellipsoideis, purpureis, 2 mm longis, longe graciliterque pedicellatis, pedicellis glabris, 3 ad 9 mm longis; glumis vacuis glabris, late ellipticis vel orbiculari-ellipticis, rotundatis, 7- vel 9-nerviis; florentibus ellipsoideis, rotundatis, glabris vel apice minutissime setuloso-puberulis, 1.8 mm longis, nitidis.

Loh Fau Mountain (Lofaushan), *Merrill 10182*, October 28, 1916, on open slopes and along small streams, widely scattered, altitude 500 to 1,150 meters.

A species manifestly allied to *Isachne globosa* (Thunb.) O. Kuntze (*I. australis* R. Brown), which is very common in swampy places at low altitudes in Kwangtung Province, but readily distinguished by its much larger size, lax, very much larger panicles, long slender branches and pedicels, and other characters. In aspect it is quite different from *Isachne globosa*, although it is manifestly allied to it. The description of *Isachne altissima* Debeaux, a copy of which was kindly supplied to me by Mr. Tutcher, does not at all conform with the characters of the Loh Fau plant. Rendle suspects Debeaux's species to be a large form of *Isachne australis* R. Br.

ORYZA Linnaeus

ORYZA SATIVA Linn. Sp. Pl. (1753) 333.

Kwangtung Province, between Sheklung and Shansaiyen, *Merrill 10380*, October 30, 1916, the wild form.

To my knowledge the wild form of the rice plant has not previously been reported from China, although wild forms are definitely known from various parts of India. De Candolle[8] states: "The five species [varieties] are considered by the Chinese as indigenous in China, and it must be admitted that this is probably the case with rice, which is in general use, and has been so for a long time, in a country intersected by canals and rivers, and hence peculiarly favourable to aquatic plants." He further concludes that while the rice plant was a native of both India and of China, that the Indians cultivated the rice plant at a date later than the Chinese, thus involving the assumption that the species must have been a native of some part of China.

The wild form of the rice plant was discovered by me in the low country of the Canton delta, where it was observed at several localities in the plain between Sheklung and Shanseiyen, the latter place being a village near the foot of Loh Fau Mountain. Here it was locally abundant in tanks, water holes, and in stagnant streams approximately at sea level. This wild form is quite different in habit and appearance from the commonly cultivated forms of the rice plant in the Canton delta. The stems, while stout, are rather

[8] Origin of Cultivated Plants (1884) 385.

weak, more or less decumbent below, showing a tendency to branch at the nodes. The panicles are lax, with widely spreading branches. The spikelets are about 8 mm long, and fall very easily; while the very slender, stiff, straight awns attain a length of 7 cm. No awned rice was observed in cultivation in the vicinity of Canton, but long-awned varieties are in common cultivation in northern Luzon. It might be mentioned in passing that no wild form of *Oryza sativa* Linn. has ever been found in the Philippines, although at least two distinct indigenous species occur in the Archipelago. The discovery of this wild form of the rice plant in southern China confirms de Candolle's opinion that rice is a native plant in China. This form has undoubtedly yielded, by selection and improvement, the various forms of rice now so extensively cultivated in southern China, the selection and improvement following the lines of strictly erect habit, unbranched culms, elimination of the awns, and persistence of the spikelets at maturity.

CYPERACEAE

CAREX Linnaeus

CAREX BREVICULMIS R. Br. var. **KINGIANA** (Lév. & Van.) Kük. in Engl. Pflanzenreich 38 (1909) 470.

Loh Fau Mountain (Lofaushan), *Merrill 10181*, on banks along small streams, altitude 1,150 meters.

Widely distributed in various forms, India to Japan southward to Australia.

CAREX FILICINA Nees in Wight Contrib. (1834) 123.

Loh Fau Mountain (Lofaushan), *Merrill 10190, 10345*, in ravines and on open slopes, altitude 500 to 1,150 meters.

India to southern China and the Philippines, with varieties in Sumatra, Borneo, and Java.

JUNCELLUS Kunth

JUNCELLUS PYGMAEUS (Nees) C. B. Clarke in Hook. f. Fl. Brit. Ind. 6 (1893) 596.

Honam Island, *Levine 210*, December, 1916.

A greately dwarfed specimen of this widely distributed species; previously recorded from China only from Kiangsu Province.

RANUNCULACEAE

CLEMATIS Linnaeus

CLEMATIS CHINENSIS Osbeck Dagbok Ostind. Resa (1757) 205, 242; Merr. in Am. Journ. Bot. 3 (1916) 579, non Retz. (1791).

Honam Island, near Canton, *Merrill 9837*, November 3, 1916, in dry thickets at low altitudes.

Osbeck observed this species in the neighborhood of Canton and at Whampoa, so that the specimen cited above is practically a topotype. It agrees entirely with the very brief description and is the only species of *Clematis* observed by me in my exploration of the country about Canton. Unfortunately, the specimen presents no flowers so that I cannot be sure as to which of the species enumerated by Dunn and Tutcher from Kwantung it pertains, although I suspect it to be *Clematis benthamiana* Hemsl. In my

specimens the leaves are ternate, or the uppermost ones simple, not "pinnatisecta 5-nata" as described by Forbes in Journ. Bot. 22 (1884) 263 (*Clematis terniflora* Benth.). *Clematis chinensis* Osbeck is not the same as *C. meyeniana* Walp. as I formerly suspected.

POLYGONACEAE

POLYGONUM Linnaeus

POLYGONUM LONGIFLORUM Courchet in Lecomte Fl. Gén. Indo-Chine 5 (1910) 31, *fig. 4.*

Honam Island, *Levine 248*, January 20, 1917.

The specimen differs from Courchet's species in its somewhat broader leaves, but agrees in all essentials with the description, the figure, and a cotype of the species in the Herbarium of the Bureau of Science. A species otherwise known only from Tonkin.

ROSACEAE

STRANVAESIA Lindley

STRANVAESIA BENTHAMIANA (Hance) comb. nov.

Photinia benthamiana Hance in Ann. Sci. Nat. Bot. V 5 (1866) 213.
Stranvaesia calleryana Decne. in Nuov. Arch. Mus. Paris 10 (1874) 179; Hemsl. in Journ. Linn. Soc. Bot. 23 (1887) 264.

Canton and vicinity, *Merrill 10083*, November 4, 1916, in fruit; *Levine 443, 448*, March, 1917, in flower.

The type of Decaisne's species was from Canton, and the specimens cited above agree perfectly with his description, and morover conform with the description of *Photinia benthamiana* Hance, the type of which was also from Kwangtung Province. The fruits are those of *Stranvaesia*, and I have accordingly transferred Hance's specific name to this genus and reduced Decaisne's species as a synonym. In general appearance the species closely approximates *Photinia*, but in addition to its fruit characters is also distinguished from the Chinese species of *Photinia* by the branches and branchlets of its inflorescences being verticillately, not racemosely arranged.

LEGUMINOSAE

INDIGOFERA Linnaeus

INDIGOFERA ZOLLINGERIANA Miq. Fl. Ind. Bat. 1^1 (1855) 310.

Honam Island, near Canton, *Merrill 10050*, October 24, 1916, in thickets at the edge of a water hole; a small tree, about 4 meters high.

This characteristic species extends from southern China and Formosa through the Philippines and the Malay Archipelago to New Caledonia. Synonyms are *Indigofera teysmanni* Miq. and *I. benthamiana* Hance; see Prain and Baker in Journ. Bot. 40 (1902) 143 and Merrill in Philip. Journ. Sci. 5 (1910) Bot. 66.

FLEMINGIA Roxburgh

FLEMINGIA PHILIPPINENSIS Merr. & Rolfe in Philip. Journ. Sci. 3 (1908) Bot. 103.

Honam Island, near Canton, *Levine 188, 263*, December, 1916 and January, 1917.

The specimens agree in all particulars with the Philippine form which is known from a few localities in northern Luzon. It is by no means certain that *Flemingia philippinensis* Merr. & Rolfe is distinct from *Flemingia yunnanensis* Franch. Pl. Delavay. (1890) 185, as the material also agrees closely with Franchet's short and imperfect description; an examination of Franchet's type will be necessary to determine the relationship of the two.

MALVACEAE

SIDA Linnaeus

SIDA MYSORENSIS W. & A. Prodr. (1834) 59.

Honam Island, near Canton, *Merrill 9904*, in waste places near houses. India to Java and the Philippines; not previously reported from China. This cannot, from Cavanilles's description, be *Sida glutinosa* Cav. to which it has been referred by some authors.

THEACEAE

EURYA Thunberg

EURYA SWINGLEI sp. nov.

Arbor parva, ramulis dense subferrugineo-villosis; foliis lanceolatis ad oblongo-lanceolatis, distichis, chartaceis vel subcoriaceis, 2 ad 3.5 cm longis, 7 ad 11 mm latis, brevissime petiolatis in siccitate flavido-viridis, supra glabris, subtus leviter pilosis, basi acutis ad rotundatis, saepius leviter inaequilateralibus, apice tenuiter acuminatis, acumine obtuso, margine obscure crenato-denticulatis vel integris; nervis lateralibus in pagina superiore obsoletis, subtus 4 ad 6, obscuris, arcuato-anastosantibus; petiolo circiter 0.5 mm longo, piloso; floribus ♀ axillaribus et e axillis defoliatis, solitariis vel binis, brevissime pedicellatis; sepalis ovatis, obtusis, haud 1 mm longis, villosis; petalis 5, oblongis, liberis, obtusis, circiter 4 mm longis et 1.5 mm latis; ovarium anguste ovoideum, dense pallide sericeo-villosum; stylis 3 vel 4, elongatis, glabris, recurvatis, 1.5 ad 2 mm longis ima in stylum elongatum cylindricum glabrum vel subglabrum 2 ad 3 mm longum connatis.

Loh Fau Mountain (Lofaushan), *Merrill 10233*, October 28, 1916, in damp shaded ravines, altitude about 1,000 meters.

A very characteristic species, conforming in many characters with *Eurya distichophylla* Hemsl., from which it is distinguished by its acuminate leaves which are pilose, not strigillose beneath, the veins obsolete on the upper surface, obscure beneath and not impressed, and its oblong, not oblong-obovate, free petals. Hemsley's description was based on a staminate specimen from Amoy. The type of the present species is a pistillate specimen, the pistillate flowers being characterized by their densely silky-villous ovaries and greatly elongated styles, which are united for the lower 2 to 3 mm. The species is dedicated to Doctor Walter T. Swingle, of the United States Department of Agriculture, through whose interest

it was possible for me to prosecute field work in Kwangtung Province. Mr. Tutcher informs me that the same form is represented in the Hongkong herbarium, from Chaochaufu, collected by Mr. Dunn.

EURYA GLANDULOSA sp. nov.

Arbor 4 ad 5 m alta, ramis crassis, glabris, ramulis junioribus plus minusve adpresse villosis glabrescentibus; foliis oblongis, brevissime petiolatis, coriaceis, flavido-viridis, 4 ad 5 cm longis, 1.5 ad 2 cm latis, basi distincte cordatis, aequilateralibus vel subaequilateralibus, apice acutis vel breviter acuminatis, margine glanduloso-crenulatis, utrinque glabris, nitidis, subtus prominente glandulosis; nervis lateralibus utrinque circiter 10, subtus prominentibus, arcuato-anastomosantibus, reticulis laxis, supra impressis, obscuris; floribus ♀ axillaribus, solitariis binis vel trinis, subsessilibus vel brevissime pedicellatis, albidis; sepalis orbiculari-ovatis, obtusis, 2 mm longis, coriaceis, extus leviter adpresse subferrugineo-pubescentibus, margine prominente brunneo-glandulosis; petalis 5, glabris, anguste oblongo-obovatis, obtusis vel leviter retusis, circiter 4 mm longis et 2 mm latis, infra distincte connatis; ovarium ovoideum, glabrum; stylis 3, circiter 1.5 mm longis ima in stylum 0.5 ad 1 mm longum cylindricum glabrum connatis.

Loh Fau Mountain (Lofaushan), *Merrill 10379*, October 28, 1916, in damp shaded ravines, altitude about 1,000 meters.

A species well characterized by its distinctly cordate, nearly equilateral leaves, which are prominently glandular on the margins and on the lower surface, and its glandular sepals. Its alliance is apparently with *Eurya amplexifolia* Dunn. and *E. obliqua* Hemsl., differing from the former in its shortly petioled, not amplexicaul leaves, and from the latter in its nearly equilateral leaves.

SYMPLOCACEAE

SYMPLOCOS Jacquin

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SYMPLOCOS GROFFII sp. nov. § *Bobua, Lohdra.*

Arbor parva, 3 ad 4 m alta, ramulis petiolisque et foliis supra ad costa et subtus ad costa nervisque prominente villosis; foliis breviter petiolatis, chartaceis, nitidis, oblongis, 6 ad 10 cm longis, 1.5 ad 2.8 cm latis, apice tenuiter acute acuminatis, margine argute serrulatis ad subintegris, basi acutis, nervis utrinque 7 ad 10, tenuibus, anastomosantibus; floribus axillaribus, fasciculatis, confertis, sessilibus vel brevissime pedicellatis, albidis; bracteis ovatis, acutis, 1.5 ad 2 mm longis, ciliato-hirsutis; calycibus lobis ovatis, rotundatis, 1 mm longis, pubescentibus; staminibus circiter 50, filamentis infra plus minusve connatis et cum petalis adnatis, glabris; petalis elliptico-oblongis, rotundatis,

5.5 ad 6 mm longis, liberis vel infra leviter connatis; ovarium pubescens, 3-loculare.

Loh Fau Mountain (Lofaushan), *Merrill 10257*, October 28, 1916, in damp shaded ravines, altitude about 1,100 meters.

A very characteristic species manifestly in the alliance with *Symplocos adenopus* Hance and *S. glandulifera* Brand. It is well characterized by its axillary, fascicled, crowded flowers, its very densely villous branchlets, and its villous leaves. From *Symplocos adenopus* Hance, the type of which was from Loh Fau Mountain, it is distinguished, among other characters, by its villous leaves, its shorter, densely villous, not glandular petioles, and pubescent ovaries, and from *Symplocos glandulifera* Brand by its smaller villous leaves which are slenderly and sharply acuminate, their margins often sharply serrulate but not glandular, densely villous, shorter petioles and branchlets, and other characters. This new species is dedicated to Mr. G. W. Groff, of the Canton Christian College, to whom I am indebted for the opportunity of visiting Loh Fau Mountain, and for numerous courtesies extended during my field work in Kwangtung Province.

VERBENACEAE

CALLICARPA Linnaeus

CALLICARPA LONGISSIMA (Hemsl.) comb. nov.

Callicarpa longifolia Lam. var. ? *longissima* Hemsl. in Journ. Linn. Soc. Bot. 26 (1890) 253.

Honam Island, near Canton, *Merrill 9986*, in villages near Canton Christian College.

The type of Hemsley's variety was from near Canton, and is the form interpreted by Hance and by Maximowicz as *Callicarpa longifolia* Lam. Lamarck's type was from Malacca, and *Callicarpa longifolia* Lam. is a species entirely distinct from this Chinese form; Hemsley states that his var. *longissima* stands out very distinctly from all others (i. e., other forms of *Callicarpa longifolia* Lam.) and perhaps should be raised to specific rank. It is distinguished from Lamarck's species by its narrow, elongated, nearly glabrous, entire or but very minutely toothed leaves, its smaller flowers, and other characters. In some respects it approaches the Philippine *Callicarpa dolichophylla* Merr., from which it is distinguished by its vegetative characters.

VITEX Linnaeus

VITEX QUINATA (Lour.) F. N. Williams in Bull. Herb. Boiss. II 5 (1905) 431.

Cornutia quinata Lour. Fl. Cochinch. (1790) 387.
Vitex loureirii Hook. & Arn. Bot. Beechy's Voy. (1841) 206, *t. 48*.

Honam Island, near Canton, *Merrill 9996*, about villages, November 3, 1916, a tree 10 to 12 meters high.

The type of *Cornutia quinata* Lour. was from Canton. It is by no means certain that Hemsley was correct in reducing *Vitex loureirii* Hook. & Arn. to *V. heterophylla* Wall., for the Chinese specimens are distinctly different from the Indian ones currently referred to Roxburgh's species. Whatever the relative status of the two species may be, Loureiro's specific name is much the older.

SCROPHULARIACEAE

ALECTRA Thunberg

ALECTRA ARVENSIS (Benth.) comb. nov.

Glossostylis arvensis Benth. Scroph. Ind. (1835) 49.
Hymenospermum dentatum Benth. in Wall. Cat. (1831) no. 3963, *nomen nudum.*
Alectra indica Benth. in DC. Prodr. 10 (1856) 339.
Alectra dentata O. Kuntze Rev. Gen. Pl. (1891) 458.

Loh Fau Mountain (Lofaushan), *Merrill s. n.*, October 28, 1916, scattered on open grassy slopes, altitude 900 to 1,000 meters.

India to Burma, southern China, northern Luzon, and Mauritius.

The oldest valid specific name is here adopted for this species; *Hymenospermum dentatum* Benth. is a *nomen nudum.*

ADENOSMA R. Brown

ADENOSMA GLUTINOSUM (Linn.) comb. nov.

Gerardia glutinosa Linn. Sp. Pl. (1753) 611; Osbeck Dagbok Ostind. Resa (1757) *t. 9.*
Digitalis sinensis Lour. Fl. Cochinch. (1790) 378.
Pterostigma grandiflorum Benth. in DC. Prodr. 10 (1846) 380.
Pterostigma rubiginosum Walp. in Nov. Act. Acad. Nat. Cur. 19 (1843) Suppl. 1: 393.
Adenosma grandiflorum Benth. ex Hance in Jorun. Linn. Soc. Bot. 13 (1874) 114.

Macao, *Callery 314*, 1844.

The oldest specific name is here adopted for this well-known species, which is represented by several collections from southern China. The Linnean type was apparently a specimen collected in Kwangtung Province by Osbeck.

ACANTHACEAE

HEMIADELPHIS Nees

HEMIADELPHIS POLYSPERMA (Roxb.) Nees in Wall. Pl. As. Rar. 3 (1832) 80.

Justicia polysperma Roxb. Fl. Ind. 1 (1820) 120.
Ruellia polysperma Roth Nov. Pl. Sp. (1821) 305.
Adenosma polysperma Spreng. Syst. 2 (1825) 829.
Hygrophila polysperma T. Anders. in Journ. Linn. Soc. Bot. 9 (1867) 456.

Honam Island, near Canton, *Merrill 10024, 10078*, October 25 and November 6, 1916, in muddy places near the river and about water holes at low altitudes.

This species is widely distributed in British India, extending to Malacca and Tonkin, but has not been previously reported from China. It appears in current literature as *Hygrophila polysperma* T. Anders., but there is no valid reason for this disposition of it, as it differs from the typical representatives of *Hygrophila* in so many characters. As a genus *Hemidelphis* is much more prominently characterized than are numerous other universally recognized genera of the *Acanthaceae.* From *Hygrophila* it is at once distinguished by its habit, its terminal, spicate, prominently brac-

teate inflorescenses, and the presence of but two stamens. In Indian material the other two stamens are reduced to staminodes, which Clarke indicates as "sometimes nearly obsolete." In the Chinese specimens the staminodes are entirely obsolete.

HYGROPHILA R. Brown

HYGROPHILA MEGALANTHA sp. nov.

Herbacea, erecta, ramosa, glabra, ramis 4-angulatis, haud lineolatis; foliis anguste oblongo-obovatis ad oblanceolatis, apice obtusis vel rotundatis, basi attenuatis, integris, obscure lineolatis, 4 ad 7 cm longis, 8 ad 15 mm latis, nervis utrique 5 vel 6, adscendentibus, obscuris; floribus paucis, in quaque axilla 1 ad 3, bracteis oblongo-lanceolatis, obtusis, 12 mm longis, bracteolis anguste oblongis, obtusis, 6 mm longis; calycibus tubo circiter 7 mm longo, laciniis anguste lineari-lanceolatis, tenuiter subcaudato-acuminatis, parcissime breviter hirsutis, tubo aequantibus; corolla 2.5 cm longa, extus parcissime breviter hirsuta, tubo infra cylindrico, supra inflato; labium superium retusum, inferius breviter 3-lobatum.

Honam Island, near Canton, *Merrill 10014*, October 26, 1916, in muddy fallow land subject to overflow by the tide, the flowers purplish-blue.

A species well characterized by its very few, unusually large flowers, and its oblong-obovate to oblanceolate, glabrous leaves. Its alliance seems to be with the form described by Nees as *Hygrophila obovata*, which Clarke has reduced to *Hygrophila quadrivalvis* Nees. It cannot possibly be referred to any form of *Hygrophila salicifolia* (Vahl) Nees (*H. angustifolia* R. Br.), or *H. quadrivalvis* Nees as these species are described.

COMPOSITAE

AINSLIAEA de Candolle

AINSLIAEA PARVIFOLIA sp. nov. § *Scaposae*.

Herba erecta, caulis infra foliis plus minusve lanuginosis, supra foliis glabris, foliis junioribus subtus parce lanuginosis; foliis rosulatis, longe petiolatis, ovatis ad oblongo-ovatis, subcoriaceis, 2.5 ad 4 cm longis, 1.2 ad 2 cm latis, supra glabris, apice acutis apiculatisque, basi cuneatis, leviter decurrentibus, margine obscure crenulatis in sinibus dentibus prominentibus calloso-apiculatis circiter 1 mm longis ornatis, nervis utrinque 2 vel 3, distantibus, prominentibus, curvato-adscendentibus, anastomosantibus, in siccitate brunneis; petiolis 3 ad 4 mm longis, glabris, vel parce lanuginosis, sursum angustissime alatis; inflorescentiis simplicibus, glabris, racemosis; capitulis breviter pedicellatis, numerosis, patulis vel adscendentibus, solitariis, circiter 15 mm longis, 3-floris, pedicellis usque ad 3 mm longis bracteis numerosis ovatis obtusis imbricatis 0.5 ad 1 mm longis obtectis; squamulis valde inaequalibus, omnibus glabris, exterio-

ribus ovatis, obtusis, circiter 1 mm longis, interioribus lineari-lanceolatis, acutis, 10 mm longis, pappum aequantibus; corolla circiter 12 mm longa, lobis linearibus, obtusis, 7 mm longis; acheniis circiter 2 mm longis adpresse subferrugineo-pubescentibus.

Loh Fau Mountain (Lofaushan), *Merrill 10237*, October 28, 1916, widely scattered on open grassy slopes, altitude 500 to 1,100 meters, the flowers white, the involucre bracts dull purple.

Beauverd,[9] in his treatment of the genus *Ainsliaea*, recognizes thirty-three species, which he distributes into three sections, *Scaposae*, *Aggregatae*, and *Frondosae*. The present species I have placed in the section *Scaposae*, as the leaves are crowded in a dense rosette, which is sometimes at the surface of the ground, at other times as much as 8 cm above the base of the plant. It appears to be allied to *Ainsliaea henryi* Diels, but differs in numerous characters, such as its long petioled, smaller, differently shaped leaves, and its much larger heads. I have not seen the description of *Ainsliaea walkeri* Hook. f., of the section *Aggregatae*, which was based on specimens cultivated at Kew derived from seeds secured by Walker in Hongkong, but this form is keyed out by Dunn and Tutcher[10] as having *linear* leaves, a character that does not at all apply to the present species.

COMPOSITAE

WEDELIA Jacquin

U5710

WEDELIA CHINENSIS (Osbeck) comb. nov.

Solidago chinensis Osbeck Dagbok Ostind. Resa (1757) 241.
Verbesina calendulacea Linn. Sp. Pl. (1753) 902.
Wedelia calendulacea Less. Syn. Compos. (1832) 222, non Pers. (1807).

Honam Island, near Canton, *Merrill 10123*, October 25, 1914, common and widely distributed on paddy banks, dry open slopes, etc.

In my consideration of the Kwangtung species described by Osbeck[11] I was unable to dispose of *Solidago chinensis* Osbeck; but now, after considerable field work in the region that Osbeck explored, I feel confident that the plant he named and very briefly described must be the form commonly known as *Wedelia calendulacea* Less. It is exceedingly common at low altitudes in Kwangtung Province, especially near the river. *Solidago virgaurea* Linn. (*S. cantoniensis* Lour.) is common on Loh Fau Mountain, extending from near its base to the summit, and I also discovered it on Honam Island, growing on open sterile slopes at an altitude of not more than 15 meters, but Osbeck's description does not at all apply to *Solidago virgaurea* Linn. *Wedelia calendulacea* Less. is untenable for this species, as the name is preoccupied by the Mexican *Wedelia calendulacea* Pers., this apparently being the earliest valid name for the plant commonly known as *Wedelia hispida* HBK. Among all the *Compositae* collected by me in Kwangtung Province, this species is the only one that conforms at all with Osbeck's description.

[9] Bull. Soc. Bot. Genève II 1 (1909) 376–385.
[10] Fl. Kwangtung and Hongkong. *Kew Bull. Add. Series* 10 (1912) 149.
[11] Am. Journ. Bot. 3 (1916) 585.

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THE DATES OF PUBLICATION OF THE THIRD EDITION OF BLANCO'S "FLORA DE FILIPINAS"

By E. D. MERRILL[1]

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

The third edition of Blanco's "Flora de Filipinas" was prepared by Father Celestino Fernandez-Villar and Father Andrés Naves, of the Augustinian Order, more than thirty years after Blanco's death. It was printed in Manila during the years 1877 to 1883, under the general editorship of Domingo Vidal y Soler, who supervised the printing of the first two volumes; the remaining volumes were printed after he had left Manila, and his place was apparently taken by his brother, Sebastian Vidal y Soler.

The first three volumes of this edition consist only of a reprint of the second edition of Blanco's work, with the addition of a Latin translation of the same. No new matter was added, so that the exact date of publication of these volumes is of little special value. Volume IV, however, contains the "Novissima Appendix" by Villar and Naves, the title page giving the date of publication as 1880, while on page 373, the printer's date for the last fascicle is given as June 15, 1883. As this is really the most important part of the third edition, and contains a number of new combinations, as well as the descriptions of some new species, the actual date of publication of the various parts is of considerable importance. In some cases the same name transfers were made by other botanists in the intervening three years, and it has previously been difficult or impossible definitely to determine which author should be credited with the transfer according to the rules of priority.

The work was issued in fascicles, and I have previously made several attempts to ascertain the dates of publication of the various parts, especially of the "Novissima Appendix," but without success. Even Father Fernandez-Villar was unable to give me any definite information as to this portion of the work, other than that a number of parts were issued in 1880, and that there was considerable delay in printing the remaining ones. Fortu-

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nately I have been able to examine a complete unbound copy of the work, in the original fascicle-covers, the property of D. Juan Javier, of Manila, and have been able definitely to determine the years in which the different fascicles were issued, according to the dates printed on the backs of the fascicle covers.

From the prospectus issued in 1877 it is learned that the plan of publication was to issue at least two and not to exceed three fascicles each month, each fascicle to consist of 16 pages of text with 6 plates. Two editions were advertised, the edition de luxe, printed on a special quality of paper accompanied by colored plates, and a cheaper edition, on poorer quality of paper, and with uncolored plates. The price per fascicle for the edition de luxe in the Philippines was fixed at $2.25, outside the Philippines $2.50, and for the cheaper edition $1.25, and $1.75 respectively; the prices were local currency (Mexican silver).

The edition de luxe was to be limited to 500 copies, which were to be numbered and each was to be inscribed with the name of the subscriber. The latter part of this plan, at least, does not seem to have been adhered to, as I have seen no numbered copies of this work among about 15 examples examined.

Volume I consists of 24 fascicles, none of which are dated. The date given on the title page of the volume is 1877, which is doubtless correct, as the prospectus was issued the same year, while Volume II appeared, in part, the following year.

Volume II consists of 27 fascicles, but of these 9 are double, that is, 2 fascicles are contained in a single cover; these double fascicles were 3-4, 6-7, 9-10, 12-13, 15-16, 18-19, 21-22, 24-25, and 26-27. Fascicles 1 to 19, consisting of pages 1 to 304, are dated on the fourth page of the covers 1878, the date given on the title page of the volume; fascicles 20 to 28, consisting of pages 305 to 419, and index, are dated 1879.

Volume III consists of 7 fascicles, of which 4 are double like those of Volume II; the double ones are 2-3, 5-6, 8-9, and 14-15. All the fascicles of this volume are dated 1879, the date given on the title page of the volume.

Volume IV consists of 24 fascicles, numbered from 1A to 23A, the last being unnumbered and indicated as "entrega ultima." Two of these are double, 4-5, and 9-10. Fascicles 1A to 12A are all dated 1880, and contain the articles by Llanos and Mercado, up to and including page 58 of Mercado's paper; fascicles 13A to the end comprise the "Novissima Appendix;" No. 13A contains also the last page of Mercado's paper and the index to the same. The dates of publication of these parts are of con-

siderable importance and are given below. No months are given, being unknown, except for the last 18 pages.

13A to 21A, Novissima Appendix, pages 1 to 272 (1880).
22A to 23A, Novissima Appendix, pages 273 to 336 (1882).
[24A] "Entrega ultima," Novissima Appendix, pages 337 to 375 (June 15, 1883).

The dates given are those printed on the fourth page of each fascicle-cover, and are probably correct. In this connection it is well to note that the introduction to the "Novissima Appendix," page IX, is dated December 12, 1880. It is possible that this was printed at a later date than were the other fascicles, otherwise it is difficult to conceive how 272 pages of this large work could be printed and distributed between December 12 and the close of the year. It is, of course, possible that the dates on the fascicle-covers are wrong, but in any event those credited to the year 1880 could scarcely have been later than 1881. If the dates given on the fascicle-covers are correct, and I know of no method of disproving them, it will be noted that no part was issued in the year 1881, and that but three parts were issued in the years 1882–1883, which corresponds with information supplied by F.-Villar in the year 1902, to the effect that a number of parts were issued in 1880, but that after that date considerable delay ensued in finishing the work.

As noted above, the edition de luxe of this work was limited to 500 copies. By no means this number is now extant, as at least a portion of the unsold ones was destroyed by fire in the burning of the Guadalupe convent, near Manila, February 19, 1899. In a letter written by Father Fernandez-Villar in the year 1902, in response to a request made by me, he informed me that many bound volumes of the work, about 4,000 unbound parts, and 16,000 plates were destroyed in the Guadalupe fire; the above figures may in part apply to the cheaper edition with the uncolored plates.

Copies of this work are not uncommon in Manila, but all that I have had the privilege of examining, here or elsewhere, with the exception of the one copy from which the above data regarding the dates of issue were taken, have been bound, and the original fascicle-covers not preserved.

Most copies of the work have the plates segregated in two volumes, but one of the copies in the library of the Bureau of Science has them scattered through the text of the four volumes. With the hope that this copy of the work might throw some light on the dates of issue of the plates, it was carefully ex-

amined. The sequence of the plates, as numbered by F.-Villar, was found only in part to approximate the sequence of issue of the fascicles as indicated by the arrangement of the plates in the above copy.

The single imperfect copy of the cheaper edition that I have seen differs from the edition de luxe in that the figures are not colored, and that each plate is numbered, while both the text and the plates are printed on cheaper paper than is the edition de luxe. The numbers assigned to the plates in the edition de luxe can be determined only by reference to the text, or to the list of plates at the end of the "Novissima Appendix" or sometimes placed with the first volume of plates. The highest number given is *plate 468*, but none were issued corresponding to the numbers *2*, *16*, *61*, *65*, *77*, *92*, *101*, *103*, *107*, *123*, *169*, *186*, *325*, and *342*, while on the other hand two different plates were assigned to the following numbers: *43*, *73*, *86*, *94*, *100*, *124*, *131*, *138*, *167*, *175*, *210*, *226*, *257*, *261*, *368*, *382*, *402*, *404*, *405*, *414*, *415*, *425*, *426*, *427*, *428*, *429*, and *442*, so that in reality complete sets of the work should contain 473 plates representing plants. However, one plate which was numbered, that is *67*, *Cyperus paniculatus*, does not appear to have been issued, as it is missing in all the sets I have examined, except one, which has a hand-made copy of the plate in question.

In connection with the above data regarding the dates of issue of this work it is well, perhaps, again to record the fact that F.-Villar was the author of the "Novissima Appendix" from page 1 to 212, and from *Fimbristylis subbispicata* on page 307 to the end of the volume; while Naves was the author of page 213 to *Fimbristylis nutans* on page 307 and was responsible for the names on the plates for the entire work.

Father Celestino Fernandez-Villar was born in Tudela, Oviedo, Spain, April 3, 1838, and died in Manila on April 28, 1907. An account of his life and work has been given by Father P. M. Vélez, under the title "Un misionero ilustre en la Ciencia, el P. Celestino Fernandez-Villar" in the periodical entitled "España y America" **5** (1907), no. 14, and **6** (1907-08) nos. 1, 9, and 10.

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TWO NEW GENERA AND FOUR NEW SPECIES OF PHILIPPINE COMPOSITAE

By E. D. MERRILL[1]
(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

TWO PLATES

In view of the facts that the *Compositae* is a family represented in the Philippines and in the Malayan region generally by comparatively few genera and species; that few of the genera are confined to this particular region; and that a high percentage of the species are manifestly introduced ones here, it is rather surprising that our recent collections should present two apparently undescribed generic types from the Philippines. There are recorded to-day from the Philippines about one hundred forty species of *Compositae*, of which but about 35 per cent are endemic. In this family it is now comparatively rare that either new species or those previously described from extra-Philippine material are discovered in the Archipelago.

In the present paper I present descriptions and figures of two new genera, while for convenience I add the descriptions of two other new species in the well-known genus *Gynura* and record two representatives of other genera as new to the Philippine flora. The drawings accompanying the present paper were made by Mr. J. K. Santos, assistant in the botanical department, College of Liberal Arts, University of the Philippines.

GUERREROIA genus novum

(Heliantheae-Coreopsidinae)

Capitula heterogama, radiata, floribus radii paucis (4 vel 5) ♀ sterilibus discique ♂ fertilibus. Involucrum parvum, bracteis 2-seriatis, basi brevissime connatis, parum inaequalibus, additis

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binis exterioribus minimis. Receptaculum planum, paleis angustis scariosis planis oblongis medio lineatis flores ☿ omnes subtendentibus onustum. Corollae ♀ ligulatae, lamina patente, grosse 2-dentata, obovata; ☿ regulares, tubulosae, limbo 4-fido, anguste campanulato. Antherae 4, basi obtusae. Styli rami in appendices subulatas desinentes. Achenia lineari-oblonga, a dorso compressa, leviter incurva utrinque leviter carinata vel costata, haud alata, calva, disco epigyno minuto coronata.—Herba perennis glabra, subacaulis, stolonifera, caudice brevissimi. Folia ad caudicem vel ad apices ramorum brevissimum conferta, oblongo-ovovata, longe petiolata, apice prominente 3- vel 5-dentata, deorsum gradatim angustata, basi cuneata. Capitula parvula, in pedunculo scapiformi aphyllo solitaria. Ligulae flavae.

GUERREROIA MONOCEPHALA sp. nov. Plate II.

Herba subglabra, subacaulis, perennis; foliis numerosis, subrosulatis, longe petiolatis, oblongo-obovatis, 1 ad 2 cm longis, apice prominente 3- vel 5-dentatis, rotundato-subtruncatis, deorsum cuneatim angustatis; capitulis solitariis, longe pedunculatis, multifloris, 10 ad 12 mm diametro; acheniis anguste oblongis, glabris, circiter 4 mm longis.

A nearly glabrous, perennial, subacaulescent herb, the very short caudex woody, thickened, bearing from one to several tufts of radiately arranged leaves on the very short stout branches, also emitting stolons up to 5 cm in length, each stolon in turn bearing a terminal tuft of leaves, the petioles sparingly pilose at the very base. Leaves numerous, all subrosulately crowded on the very short caudices, their petioles slender, 1.5 to 4 cm in length, the blades oblong-obovate, chartaceous to subcoriaceous 1 to 2 cm long, 5 to 7 mm wide, the subtruncately rounded apex prominently 3- or 5-toothed, the teeth triangular, acute, gradually narrowed from the apex to the base, cuneate. Peduncles solitary, 5 to 10 cm long, each bearing a single head, the heads 10 to 12 mm in diameter, the outer two bracteoles linear, about 1.5 mm long, free, the inner ones 2-seriate, subequal, about 10 in number, slightly united at the base, glabrous, oblong, obtuse, about 3 mm long. Ray flowers about 4, yellow, the tube 1.5 mm long, the limb broadly obovate, 4 to 4.5 mm long, 3.5 to 4 mm wide, prominently 5-nerved, apex coarsely 2-toothed; style slightly exserted from the tube, the arms 0.5 mm long or less. Achenes sterile, flattened, about 1 mm long, sligthly 2-toothed at the apex. Paleae subtending the disk flowers flat, oblong, obtuse, 3 mm long. Corolla 3 to 3.5 mm long, the tube 2 to 2.5 mm long,

the limb somewhat campanulate, the lobes 4, ovate, obtuse, 1 mm long or less; style-arms 1.5 to 2 mm long. Achenes, in anthesis, flattened, about 1 mm long, when mature slightly curved, smooth, glabrous, flattened, sligthly curved, narrowly oblong, about 4 mm long and 1 mm wide, rather distinctly keeled inside and obscurely so outside, slightly narrowed at the tip and crowned with the very minute obscure corona.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27526 Ramos*, March 9, 1917, on dry open hills at low altitudes, "flowers white and yellow."

The alliance of this new genus is with *Chrysanthellum* and *Glossogyne*, but it differs radically from both of these in many characters. It is distinguished from both in being nearly acaulescent and stoloniferous, and in its solitary, long-peduncled heads. Among other characters it differs from *Glossogyne* in its unawned achenes and from *Chrysanthellum* in being perennial, unbranched or with but the very short thickened branches of the caudex, in its solitary, long-peduncled heads, crowed, subrosulate, long-petioled leaves, and other characters. The long-petioled leaves, which are oblong-obovate in outline, subtruncate and prominently 3- or 5-toothed at the apex, and cuneately narrowed below, are very characteristic.

The new genus is dedicated to Dr. Leon Ma. Guerrero in commemoration of his knowledge of Philippine pharmacy and botany and his deep interest in the study of our local medicinal plants.

FENIXIA genus novum

(*Heliantheae-Verbesinae*)

Capitula heterogamia, radiata, floribus radii ♀ 2, sterilibus, disci 5, ♀ fertilibus. Involucrum anguste campanulatum, bracteis 6, 2-seriatis, herbaceis, lanceolatis, acuminatis, hirsutis, interioribus brevioribus. Receptaculum minimum, convexiusculum vel subplanum, glabrum, nudum. Corollae ♀ ligulatae, patentes, laminis obovatis, 3-dentatis; ♀ regulares, tubulosae, limbo breviter 4-fido. Antherae 4, basi breviter 2-dentatae. Styli rami complanati, acuminati. Achenia compressa, oblongo-obovata, crasse bialata, rugosa, sursum leviter hirsuta, margine irregulariter crenata, apice obtusa, calva.—Herba annua, ramosa, strigosa. Folia opposita, subovata, acute serrata. Capitula parva, pauciflora, in axillis foliorum tenuiter pedunculata, pedunculis solitariis. Corollae radii flavae. Achenia indurata, rugosa, apice plus minusve hirsuta.

FENIXIA PAUCIFLORA sp. nov. Plate III.

Herba erecta vel suberecta, ramosa, usque ad 40 cm alta, hirsuto-strigosa, ramis ramulisque tenuibus; foliis oppositis, membranaceis, subovatis, usque ad 2.5 cm longis, acutis vel obscure acuminatis, basi late subrotundatis ad subacutis, nervis utrinque 2 vel 3, obscuris; capitulis in axillis superioribus, solitariis, paucifloris, tenuiter pedunculatis, anguste campanulatis,

circiter 8 mm longis, floribus flavis, concoloribus; bracteis 6, 2-seriatis, strigoso-hirsutis, membranaceis, lanceolatis, acuminatis, exterioribus 5 ad 6 mm longis, interioribus brevioribus; floribus ♀ 2, ligulatis, 7 ad 8 mm longis ♀ tubulosis, circiter 5 mm longis, breviter 4-fidis, extus parce hirsutis; acheniis oblongo-obovatis, induratis, 3.5 ad 4 mm longis, in siccitate brunneis, rugosis, obtusis, apicem versus plus minusve hirsutis, calvis, prominente bialatis, alis crassis, margine irregulariter crenatis.

MINDANAO, Bukidnon Subprovince, Gaboc, Tanculan, *Bur. Sci. 26036 Eugenio Fénix*, July 13, 1916, on damp rocky hillsides associated especially with *Begonia*.

This genus is anomalous in the *Heliantheae-Verbesinae* in that the receptacle is entirely destitute of paleae, but in spite of this, its alliance is apparently with *Eclipta*. In *Eclipta* the paleae of the receptacle are very slender, and are frequently entirely absent among the central flowers of the head. It is probable that the absence of paleae in the present genus may be due to the great reduction of the heads, there being but two sterile pistillate flowers and five perfect fertile flowers in each head. The indurated rugose achenes somewhat resemble those of *Eclipta*, differing in shape and in the prominent, thick, marginal wings.

The genus is dedicated to Mr. Eugenio Fénix, who collected the specimens and who for about fifteen years has been a most efficient assistant in the herbarium of the Bureau of Science.

GYNURA Cassini

GYNURA SUBGLABRA sp. nov.

Scandens, inflorescentiis leviter castaneo- vel subferrugineo-pubescentibus exceptis glabra, ramis prominente 4- vel 5-angulatis; foliis membranaceis ad chartaceis, in siccitate atro-brunneis, usque ad 17 cm longis, acuminatis, sessilibus, basi biauriculatis, margine irregulariter dentatis; inflorescentiis axillaribus terminalibusque, longe pedunculatis; capitulis circiter 1.5 cm longis, multifloris; bracteolis circiter 10, glabris, lineari-lanceolatis, acuminatis, circiter 12 mm longis.

A coarse scandent plant entirely glabrous except the more or less castaneous- or subferruginous-pubescent inflorescences. Branches stout, brown, prominently 4- or 5-angled, 5 to 8 mm in diameter. Leaves sessile, membranaceous to chartaceous, dark-brown when dry, dull or slightly shining, oblong to oblong-ovate, 9 to 17 cm long, 4 to 6 cm wide, margins rather coarsely dentate, apex acuminate, base somewhat narrowed and prominently biauriculate, the auricles irregular, angled or toothed, 1 to 2 cm long, in general ovate or rhomboid-ovate. Inflorescences axillary and terminal, long-peduncled, each with 6 to 12 heads of yellow flowers, the peduncles up to 20 cm in length, the

younger branchlets pubescent, otherwise glabrous. Heads about 1.5 cm long, each peduncle with several, scattered, filiform bracts usually about 5 mm in length. Bracteoles about 10, linear-lanceolate, acuminate, about 12 mm long, glabrous. Achenes glabrous.

LUZON, Abra Province, Mount Posuey, *Bur. Sci. 27023 Ramos*, February 4, 1917, climbing over shrubs on damp forested slopes.

In many respects this species resembles *Gynura bicolor* DC. and *G. angulosa* DC., but differs from both in being scandent, not erect, and from the former in its sessile, not petioled leaves.

GYNURA ACUMINATISSIMA sp. nov.

Erecta, glabra, usque ad 50 cm alta; foliis lanceolatis, membranaceis, longissime acuminatis, basi decurrento-acuminatis, usque ad 20 cm longis et 4 cm latis, margine distanter irregulariter dentatis vel denticulatis, nitidis; inflorescentiis laxis, corymbosis, ramis elongatis; capitulis circiter 1.5 cm longis, bracteolatis, bracteis lineari-lanceolatis, circiter 12 mm longis.

An erect glabrous or nearly glabrous plant, attaining a height of 50 cm, the stems below attaining a diameter of 5 mm, terete, brown. Leaves somewhat crowded on the lower part of the stem, lanceolate, membranaceous, brownish when dry, shining, 17 to 20 cm long, 3 to 4 cm wide, gradually narrowed upward to the long and slenderly acuminate apex, the base decurrent-acuminate, the margins distantly and irregularly toothed, or sometimes merely denticulate, the smaller reduced leaves subtending the branches sessile, often laciniate-lobed in the lower part, the petioles of the normal leaves 2 to 4 cm long. Inflorescence corymbose, lax, the branches slender, elongated, up to 20 cm long, each primary branch bearing two or three heads on long, slender, slightly pubescent branchlets. Heads about 1.5 cm long, each subtended by about 10, linear, glabrous, 6 mm long bracteoles. Involucral bracts linear-lanceolate, glabrous, about 3 mm wide and 12 mm long, glabrous. Flowers numerous, yellow. Corolla-tube slender, about 12 mm long, the upper 2 mm of the tube somewhat inflated, the lobes 2 mm long, slightly pubescent at their tips. Achenes cylindric, ribbed, 3 mm long. Pappus copious, white, 8 to 10 mm long. Disk conspicuously alveolate, the margins of the alveolae produced, scale-like, about 0.5 mm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26556 Ramos & Edaño*, August 26, 1916, on slopes at medium altitudes.

A most characteristic species, readily distinguished from its congeners in its glabrous, lanceolate, very slenderly acuminate leaves.

PTEROCAULON Elliott

PTEROCAULON REDOLENS (Forst.) F.-Vill. Novis. App. (1880) 116; Boerl. Handl. Kenn. Fl. Nederl. Ind. 2[1] (1891) 240.

Gnaphalium redolens Forst. Prodr. (1786) 91.
Conyza redolens Willd. Sp. Pl. 3 (1800) 1951.
Moneteles redolens DC. Prodr. 5 (1836) 455.
Moneteles spicatus Labill. Sert. Austro-Caledon. (1824) 43, *t. 43*.
Tessaria redolens Less. in Linnaea 6 (1831) 151.
Gnaphalium cylindrostachyum Wall. Cat. (1831) no. 3931, *nomen nudum*.
Sphaeranthus elongatus Blanco Fl. Filip. (1837) 636.
Pterocaulon cylindrostachyum C. B. Clarke Comp. Ind. (1876) 98.

Tessaria redolens Less. was credited to Luzon in Linnaea 6 (8131) 151, the reference to Chamisso's specimen being repeated in de Candolle's Prodromus under *Moneteles redolens* DC. I do not see, from the descriptions available, how *Gnaphalium redolens* Forst. can be distinguished from the species more commonly known as *Pterocaulon cylindrostachyum* C. B. Clarke, and have accordingly accepted *Pterocaulon redolens* (Forst.) F.-Vill. as the proper name for the species, which is of local occurrence in the Philippines, growing in open dry places at low altitudes. This is one of the numerous transfers made by F.-Villar in the Novissima Appendix to the third edition of Blanco's Flora de Filipinas that were overlooked by the compilers of Index Kewensis.

ARTEMISIA Linnaeus

ARTEMISIA JAPONICA Thunb. Fl. Jap. (1784) 310.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27500 Ramos*, February 26, 1917, in dry open places at low altitudes.

The specimen is scarcely typical *Artemisia japonica* Thunb., but apparently represents a form of this species. Japan to Formosa and southern China.

ILLUSTRATIONS

[Drawings by J. K. Santos.]

PLATE II. *Guerreroia monocephala* Merr.

a. Habit sketch of a flowering plant, natural size.
b. Anthers. × 20.
c. Involucral bract. × 5.
d. Palea. × 5.
e. Disk flower. × 5.
f. Ray flower. × 5.
g. Stigma. × 20.
h. Achenes. × 4.5.

III. *Fenixia pauciflora* Merr.

a. Habit sketch. × 0.5.
b. A leaf, natural size.
c. A head in anthesis. × 3.
d. A ray flower. × 4.
e. A disk flower. × 4.
f. Stigma. × 20.
g. Anthers. × 20.
h. Achenes, dorsal and ventral views. × 4.
i. A head in fruit. × 3.

PLATE II. GUERREROIA MONOCEPHALA MERR.

PLATE III. FENIXIA PAUCIFLORA MERR.

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NEW PHILIPPINE LAURACEAE

By E. D. MERRILL[1]

(From the Botanical Section of the Biological Laboratory, Bureau of Science, Manila, P. I.)

The present paper consists chiefly of the descriptions of nineteen species of *Lauraceae* in the genera *Cinnamomum, Cryptocarya, Litsea,* and *Phoebe,* with a note on *Litsea albayana* Vid.; *Cryptocarya griffithiana* Wight is credited to the Philippines, and *Endiandra vidalii* Elm. is transferred to *Cryptocarya* where it properly belongs.

CINNAMOMUM Linnaeus

CINNAMOMUM MYRIANTHUM sp. nov.

Arbor parva, haud aromatica, inflorescentiis exceptis glabra; ramis ramulisque teretibus, laevis, brunneis; foliis oppositis, coriaceis, ovatis ad oblongo-ovatis, usque ad 11 cm longis, obtusis vel brevissime obtuse acuminatis, basi acutis, prominente triplinerviis, nervis apice non attingentibus, supra laevis, nitidis, subtus distincte dense jejeune foveolato-reticulatis; paniculis terminalibus, circiter 15 cm longis, multifloris, plus minusve adpresse griseo-pubescentibus; floribus pedicellatis, 5 mm longis, segmentis extus prominente, pubescentibus, indumentum nitidum; staminibus fertilibus 9, circiter 3 mm longis, staminoideis stipitatis, lanceolatis, acuminatis.

A tree about 5 m high, glabrous except the rather prominently pubescent inflorescence, the leaves and the cortex of the younger branches not at all aromatic when dry. Branches and branchlets brown, terete, smooth. Leaves opposite, coriaceous, ovate to oblong-ovate, 8 to 11 cm long, 4 to 5.5 cm wide, narrowed upward to the obtuse or shortly and obtusely acuminate apex, base acute, prominently 3-plinerved, the upper surface smooth, shining, rather pale when dry, the lower surface of nearly the same color, duller, distinctly and densely foveolate-reticulate, the foveolae shallow, mostly about 0.5 mm in diameter; lateral nerves leaving

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the midrib about 1 cm above the base, evanescent or obscurely anastomosing with a supplementary pair of lateral nerves leaving the midrib above the middle of the leaf at about three-fourths the length of the leaf, not reaching the apex; sometimes a very faint additional pair of basal nerves close to the margin is present; petioles reddish-brown or brown, 1.5 cm long. Panicles terminal, ample, many flowered, up to 15 cm in length, the rachis and primary branches sparingly pubescent, the younger branchlets, pedicels, and perianth-segments prominently appressed-pubescent with pale or grayish, shining hairs; pedicels 3 to 6 mm long. Flowers about 5 mm long, the tube 1.8 mm long. Perianth-segments elliptic-oblong, obtuse, 3 to 4 mm long. Fertile stamens 9, about 3 mm long, the filaments pubescent below, the third row with prominent glands at about the middle of the filaments; staminodes stipitate, lanceolate, acuminate. Ovary ellipsoid, glabrous; style 2 mm long.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27485 Ramos*, February 22, 1917, in forests at low altitudes, Il. *pelling*.

This species is characterized among the Philippine forms by being non-aromatic, in its prominently triplinerved leaves, the basal nerves attaining about the upper three-fourths of the leaf; and its leaves being distinctly but shallowly foveolate-reticulate on the lower surface. In general aspect it somewhat resembles *Cinnamomum zeylanicum* Nees, but is not closely allied to that species.

CINNAMOMUM SANDKUHLII sp. nov. § *Malabathrum*.

Arbor, ramulis foliis junioribus et inflorescentiis dense molliter griseo-pubescentibus; foliis oppositis vel suboppositis, coriaceis, oblongis ad oblongo-ellipticis, usque ad 18 cm longis, nitidis, basi acutis, prominente 3-plinerviis, apice obtusis vel subacutis; paniculis circiter 20 cm longis, floribus circiter 4 mm longis.

A tree, the younger branchlets, lower surfaces of the leaves, and the inflorescence densely and softly gray-pubescent, the indumentum also present on the upper surface of the leaves, more or less deciduous, the very old leaves glabrous on both surfaces. Branches terete, reddish-brown, glabrous. Leaves opposite or subopposite, thickly coriaceous, oblong-elliptic, 10 to 18 cm long, 3.5 to 6.5 cm wide, base acute, apex obtuse to acute, the upper surface very smooth and shining, the lower dull at first, in age shining; base prominently 3-plinerved, the midrib and basal nerves very prominent on both surfaces, the basal pair extending nearly to the apex of the leaf, with transverse nervules between the midrib and the lateral nerves, but without primary nerves; petioles up to 1.5 cm long, densely pubescent when young, in age quite glabrous. Panicles in the upper axils,

about 20 cm long, rather densely and softly gray-pubescent. Buds obovoid. Flowers about 4 mm long, externally densely pubescent, the perianth lobes oblong-obovate, rounded. Stamens 9, all 4-celled. Ovary glabrous, ovoid; style about 1 mm long.

LUZON, Benguet Subprovince, Baguio, *For Bur. 21289 Sandkuhl,* April, 1914, a single tree in Forbes Park, altitude about 1,400 meters.

A species well characterized by its soft dense indumentum, in this character differing from all known Philippine forms. Its alliance seems to be with *Cinnamomum mollissimum* Hook. f. of the Malay Peninsula from which it is readily distinguished by its acute or obtuse, not acuminate leaves, glabrous ovary, and many other characters.

CRYPTOCARYA R. Brown

CRYPTOCARYA LANCEOLATA sp. nov.

Arbor parva inflorescentiis et ramulis junioribus minute cinereo-puberulis exceptis glabra; foliis subcoriaceis, lanceolatis, nitidis, usque ad 17 cm longis, basi acutis, apice gradatim angustatis, leviter acuminatis, nervis utrinque circiter 7, adscendentibus, curvatis, vix anastomosantibus, reticulis tenuibus, confertis, subtus jejeune foveolatis; infructescentibus terminalibus et in axillis superioribus, usque ad 10 cm longis, cinereo-puberulis; fructibus globosis vel globoso-ovoideis, glabris, nitidis, laevis, circiter 12 mm diametro, in siccitate nigris vel olivaceo-nigris.

A small tree, the young branchlets and inflorescence cinereous-puberulent, otherwise glabrous. Branches somewhat olivaceous and slightly wrinkled when dry. Leaves alternate, lanceolate, subcoriaceous, shining, 10 to 17 cm long, 2.5 to 5 cm wide, the upper surface grayish-olivaceous, very smooth, and prominently shining, the lower paler, base acute, apex obscurely acuminate, gradually narrowed upward from the lower one-third or one-half; lateral nerves about 7 on each side of the midrib, ascending, curved, scarcely anastomosing, distinct, the ultimate reticulations close, fine, the lower surface shallowly foveolate; petioles 3 to 6 mm long, when young cinereous-puberulent. Panicles in the uppermost axils and terminal, forming a somewhat leafy terminal inflorescence, up to 10 cm in length. Fruit globose or globose-ovoid, about 12 mm in diameter, black or olivaceous when dry, smooth, glabrous, shining.

LUZON; Ilocos Norte Province, Buagao, *For. Bur. 25098 Paraiso,* February 21, 1916, on slopes at an altitude of about 100 meters.

A species well characterized by its lanceolate leaves, with rather distant, ascending, curved nerves, and very close ultimate reticulations which are shallowly foveolate on the lower surface.

CRYPTOCARYA CINNAMOMIFOLIA sp. nov.

Arbor parva, novellis ferrugineo-pubescentibus exceptis glabra, ramis ramulisque tenuibus, teretibus, rubro-brunneis; foliis firmiter chartaceis, oblongis, usque ad 15 cm longis, prominente tenuiter acuminatis, basi acutis, 3-plinerviis, nervis longitudinalis prominentibus apice subattingentibus, tranversis tenuibus, obscuris; inflorescentiis axillaribus, solitariis, racemosis, paucifloris, 2 ad 3 cm longis; floribus circiter 6 mm longis.

A small tree, 5 m high according to the collector, entirely glabrous except the ferruginous-pubescent buds, a few hairs sometimes persisting on the youngest branchlets. Branches and branchlets slender, terete, smooth, reddish-brown. Leaves longitudinally 3-ribbed, oblong, firmly chartaceous, 8 to 15 cm long, 2.8 to 5.5 cm wide, shining, smooth, the upper surface brownish or grayish-olivaceous, the lower paler, the apex prominently and slenderly acuminate, the base acute, prominently 3-plinerved, the longitudinal nerves extending nearly to the apex; lateral transverse nerves very slender, obscure, irregular, straight, anastomosing with the longitudinal ones, the reticulations lax, obscure, or nearly obsolete; petioles about 1 cm long. Racemes axillary, solitary, 2 to 3 cm long, each 4- to 6-flowered, glabrous or nearly so, the pedicels 2 to 3 mm long. Flowers greenish-yellow. Perianth-tube 2.5 mm long, somewhat cuneate, the lobes 6, oblong, obtuse, 3 mm long. Stamens 9, their filaments very slightly pubescent, about 2 mm long, the anthers all 2-celled; stipitate glands prominent, about 1.5 mm long. Ovary narrow, including the style 4.5 mm in length.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26317 Ramos & Edaño*, August 6, 1916, on forested slopes at low altitudes.

This species, in general appearance, differs so radically from the other forms of *Cryptocarya* known to me that I have hesitated in placing it in this genus. Its notable characters are its 3-plinerved, longitudinally ribbed, *Cinnamomum*-like leaves, and its short, few-flowered, axillary racemes. In floral structure, however, it seems to conform to *Cryptocarya*, and I have accordingly placed it in this genus.

CRYPTOCARYA OLIGOPHLEBIA sp. nov.

Arbor circiter 18 m alta, ramulis inflorescentiisque plus minusve breviter pubescentibus, subtus foliis ad costa nervisque parcissime pubescentibus; foliis oblongo-ovatis, chartaceis vel subcoriaceis, olivaceis, nitidis, usque ad 12 cm longis, basi acutis ad rotundatis, sursum sensim angustatis, acuminatis, nervis utrinque 3 vel 4; paniculis axillaribus terminalibusque, multifloris, usque ad 15 cm longis, floribus in ramulis ultimis plus minusve confertis, circiter 4 mm longis, extus pubescentibus.

A tree about 18 m high, the branches and branchlets rather slender, terete, dark when dry, the younger ones sparingly pubescent with short hairs. Leaves chartaceous to subcoriaceous, oblong-ovate, dark-olivaceous on both surfaces when dry, the lower slightly paler than the upper, 9 to 12 cm long, 3 to 5 cm wide, base acute to somewhat rounded, gradually narrowed upward from the lower one-third or one-half to the acuminate apex, the acumen blunt; both surfaces, or the lower one only, very sparingly appressed-pubescent on the midrib and nerves, the ultimate reticulations shallowly foveolate, dense, about equally prominent on both surfaces; lateral nerves 3 or 4 on each side of the midrib, curved-ascending, slender but distinct; petioles somewhat pubescent, about 5 mm long. Panicles terminal and axillary, ample, many flowered, up to 14 cm long, the branches alternate, spreading or somewhat ascending, the lower ones up to 6 cm long. Flowers white, numerous, somewhat crowded on the ultimate branchlets, the younger parts of the inflorescence and the flowers rather prominently pale-brownish-pubescent. Flowers about 4 mm long, the tube cylindric, slightly inflated, about 1.8 mm long, the lobes slightly longer than the tube, ovate to oblong-ovate, obtuse to subacute, externally pubescent.

BASILAN, *Bur. Sci. 16155 Reillo*, August 19, 1912 (type), *For. Bur. 18883, 18844 Miranda*, August, 1912, in forests, altitude 20 to 200 meters.

A species well characterized by its few-nerved leaves and its ample, many-flowered panicles; it is quite different from all other species known to me. Perhaps two of the specimens cited above are from the small island of Malamaui, near Basilan, judging, from the field labels. *Bur Sci. 16155 Reillo* and *For. Bur. 18883 Miranda* were both collected on August 19, and both indicated as from Basilan, but the latter bears the additional statement "from the forests of Malamaui."

CRYPTOCARYA OBLONGATA *sp. nov.*

Arbor, partibus junioribus subtus foliisque ad costa nervisque minute adpresse ferrugineo-pubescentibus; foliis coriaceis, oblongis, usque ad 14 cm longis, apice breviter acuminatis, basi cuneatis, supra glabris, laevis, leviter nitidis, olivaceis, subtus brunneis et leviter glaucescentibus, nervis utrinque 10 ad 12, suberectis, subtus valde prominentibus; paniculis axillaribus, brevibus, fructibus anguste ovoideis, nitidis, laevis, glabris, circiter 2 cm longis.

A tree, nearly glabrous (flowers not known). Branches terete, slender, dark reddish-brown when dry, glabrous, the very young branchlets pubescent. Leaves oblong, coriaceous, 8 to 14 cm long, 2 to 4 cm wide, the apex shortly acuminate, base

cuneate, the upper surface olivaceous, smooth, somewhat shining, glabrous, the lower surface brownish and slightly glaucescent when dry; lateral nerves 10 to 12 on each side of the midrib, very prominent on the lower surface, obscure on the upper surface, nearly straight, somewhat ascending, the reticulations not prominent, the midrib and lateral nerves on the lower surface minutely appressed-pubescent with short brown or reddish-brown hairs; petioles about 1 cm long, nearly black when dry, glabrous. Panicles axillary, solitary, in fruit about 2.5 cm long. Fruits narrowly ovoid, about 2 cm long, 10 to 12 mm in diameter, dark brown, smooth and shining when dry.

LUZON, Tayabas Province (Principe), Baler, *Merrill 1033* (coll. *Garcia*), August, 1902, locally known as *pusihan*.

Apparently as closely allied to **CRYPTOCARYA VIDALII** (Elm.) (*Endiandra vidalii* Elm.) as to any other species, but with much more numerous lateral nerves and smaller fruits.

CRYPTOCARYA SAMARENSIS sp. nov.

Arbor circiter 18 m alta, subtus foliis ramulisque minute adpresse puberulis. Foliis oblongis, subcoriaceis, usque ad 11 cm longis, in siccitate utrinque brunneis, apice tenuiter acuminatis, basi acutis, nervis utrinque circiter 8, subtus prominentibus; fructibus oblongo-ellipsoideis, circiter 2.5 cm longis, utrinque leviter angustatis, in siccitate nigris, nitidis, laevis.

A tree about 18 m high, nearly glabrous, the young branchlets and the lower surfaces of the leaves minutely appressed-puberulent. Branches slender, terete, brownish. Leaves oblong, subcoriaceous, 8 to 11 cm long, 2.5 to 4 cm wide, the base acute, apex rather slenderly and sharply acuminate, both surfaces brown when dry or the upper surface brownish-olivaceous, shining, smooth; lateral nerves about 8 on each side of the midrib, prominent, curved-ascending, the reticulations slender, distinct; petioles slender, about 1 cm long. Flowers not seen. Panicles axillary, mostly 2 to 5 cm long, some up to 12 cm in length, the branches few, short, glabrous. Fruits oblong-ellipsoid, smooth, black and shining when dry, slightly and subequally narrowed at both ends, 2 to 2.5 cm long, about 1 cm in diameter.

SAMAR, Cauayan Valley, *Bur. Sci. 17531 Ramos*, March 27, 1914, in forests along small streams, locally known as *malaigot*.

A species somewhat resembling *Cryptocarya glauciphylla* Elm., from which it differs, among other characters, in its brown leaves which are minutely appressed-puberulent on the lower surface.

CRYPTOCARYA ZAMBOANGENSIS sp. nov.

Arbor 7 ad 12 m alta, partibus junioribus ferrugineo-pubescent-

ibus; foliis oblongis ad late oblongis, usque ad 18 cm longis, basi acutis ad rotundatis, apice latissime breviter obtuseque acuminatis, subcoriaceis, subtus ad costa nervisque subdense minute pubescentibus, nervis utrinque circiter 9, prominentibus; paniculis axillaribus terminalibusque, usque ad 18 cm longis; floribus pubescentibus, circiter 5 mm longis; fructibus junioribus ovoideis, leviter pubescentibus, longitudinaliter striatis.

A tree 7 to 12 m high, the younger parts rather prominently ferruginous-pubescent with short hairs. Branches terete, reddish-brown, slightly pubescent, the young branchlets rather densely pubescent. Leaves oblong to broadly oblong, subcoriaceous, olivaceous or somewhat pale when dry, slightly shining, the lower surface browner than the upper, 11 to 18 cm long, 4 to 8 cm wide, base acute to rounded, apex rather abruptly, shortly, and very obtusely acuminate, the upper surface glabrous or somewhat pubescent on the midrib and the lateral nerves, the lower surface minutely and often rather densely pubescent on the midrib, lateral nerves, and usually the primary reticulations, in age often becoming nearly glabrous; lateral nerves about 9 on each side of the midrib, prominent, curved-ascending, usually distinctly impressed on the upper surface, the ultimate reticulations dense, shallowly foveolate on both surfaces; petioles about 1 cm long, pubescent. Panicles axillary and terminal, rather densely ferruginous-pubescent, especially the younger parts, up to 18 cm in length, often much shorter, the primary branches distant, spreading. Flowers whitish, pubescent, the perianth tube ovoid, about 2 mm long, the lobes subequal, oblong to oblong-obovate, acute, about 3 mm long. Young fruits ovoid, somewhat pubescent, about 8 mm long, obtuse, distinctly longitudinally striate.

MINDANAO, Zamboanga District, Siay River, *For. Bur. 13395 Foxworthy, Demesa, & Villamil* (type), May 29, 1912; Sax River, *Williams 2301*, February 4, 1905; Tetuan, *Ahern 583*. The native name indicated by Foxworthy is *taming-taming;* by Quadras (*Ahern 583*) *pulipup.*

A species similar to *Cryptocarya palawanensis* Merr., from which it differs essentially in its somewhat smaller, fewer-nerved leaves.

CRYPTOCARYA GRIFFITHIANA Wight Ic. (1852) *t. 1830.*

MINDANAO, Lanao District, Kalambugan, *For. Bur. 23179 Agama*, November 6, 1914, in forests, altitude not indicated.

The specimen agrees so closely with a rather full series of specimens representing *Cryptocarya griffithiana* Wight, from the Malay Peninsula, that I cannot detect any constant characters by which it can be distinguished and I have accordingly no hesitation in referring this Mindanao plant to Wight's species.

Tenasserim to Singapore; new to the Philippines.

LITSEA Lamarck

LITSEA ILOCANA sp. nov.

Arbor parva, ramulis junioribus et inflorescentiis ferrugineo-puberulis, ceteroquin glabra; ramis ramulisque teretibus, brunneis vel rubro-brunneis; foliis oppositis vel suboppositis, coriaceis, in siccitate pallidis, nitidis, lanceolatis, usque ad 13 cm longis, utrinque subaequaliter angustatis, basi acutis, apice obtusis vel obscure obtuseque acuminatis, nervis utrinque circiter 9, curvatis, obscure anastomosantibus; fructibus axillaribus, fasciculatis, brevissime pedicellatis, calycibus accrescentibus, circiter 8 mm diametro, fructibus oblongis ad oblongo-ellipsoideis, circiter 1.4 cm longis, minute apiculatis.

A small tree, the young branchlets, petioles, and inflorescences rather densely ferruginous-puberulent, soon becoming glabrous. Branches and branchlets terete, brown or reddish-brown. Leaves mostly opposite or subopposite, lanceolate, coriaceous, 8 to 13 cm long, 2 to 3.5 cm wide, subequally narrowed to the acute base and to the blunt or very obscurely blunt-acuminate apex, shining on both surfaces, the upper surface pale greenish when dry; lateral nerves about 9 on each side of the midrib, slender, curved, obscurely anastomosing, the ultimate reticulations fine, close, the upper surface smooth, the lower shallowly and minutely foveolate; petioles about 5 mm long. Fruits axillary, usually three developing from each very short peduncle, the very short stout pedicels not exceeding 2 mm in length. Accrescent calyx about 8 mm in diameter, brown, thickly coriaceous, obconic. Fruit oblong to oblong-elliptic, about 1.4 cm long, brown when dry, apiculate.

LUZON, Ilocos Sur Province, Talinaaden, *For Bur. 25485 Paraiso*, March 25, 1916, on slopes at an altitude of 450 meters.

A species belonging in the general group with *Litsea luzonica* F.-Vill., but quite different from that species in its vegetative characters.

LITSEA ABRAENSIS sp. nov.

Arbor glabra, circiter 10 m alta, ramis teretibus, ramulis in siccitate nigrescentibus, teretibus vel obscure angulatis; foliis alternis, coriaceis, oblongis ad oblongo-ellipticis, usque ad 12 cm longis, supra nitidis, laevis, viridi-olivaceis, subtus glaucescentibus, apice acute acuminatis, basi acutis, nervis utrinque circiter 8, prominentibus, curvato-anastomosantibus, reticulis tenuibus, obscuris; umbellulis 4- vel 5-floris, racemose dispositis, racemis axillaribus, 4 ad 7 cm longis; bracteis 4, extus minute parce puberulis, in siccitate nigrescentibus, concavis, orbiculari-ovatis, 7 ad 8 mm diametro; floribus glabris, segmentis oblongo-lan-

ceolatis, acuminatis, 5 mm longis, glabris vel margine obscurissime ciliatis; staminibus fertilibus 12, filamentis exterioribus eglandulosis.

A glabrous tree about 10 m high, or the younger parts obscurely and sparingly cinereous-puberulent. Branches terete, grayish-brown, rugose, the branchlets, petioles, and inflorescences characteristically black or blackish when dry. Leaves alternate, coriaceous, oblong to oblong-elliptic, 8 to 12 cm long, 3 to 5 cm wide, apex acutely acuminate, base acute, the upper surface greenish-olivaceous, the lower somewhat glaucous; lateral nerves about 8 on each side of the midrib, prominent, curved-ascending, obscurely anastomosing, the reticulations slender, not prominent, obsolete on the upper surface; petioles 1.5 to 2 cm long. Inflorescences racemose, axillary; 4 to 7 cm long, each with about 8 umbels, these with 4 to 7 mm long peduncles, 4- or 5-flowered; bracts 4, black when dry, glabrous or externally obscurely and slightly cinerous-puberulent, orbicular-ovate, concave, 7 to 8 mm in diameter. Flowers yellowish, shortly pedicelled. Perianth segments oblong-lanceolate, acuminate, about 5 mm long, glabrous or their margins obscurely ciliate. Fertile stamens 12, the filaments of the outer two rows 3 to 5 mm long, eglandular, those of inner two rows prominently biglandular at the base. Rudimentary ovary narrowly ovoid, glabrous.

LUZON, Abra Prvince, Mount Posuey, *Bur. Sci. 27048 Ramos*, February 4, 1917, on damp forested slopes.

This belongs in the small group of species with the umbels arranged in somewhat elongated axillary racemes, such as *Litsea anomala* Merr., *L. leytensis* Merr., and *L. plateaefolia* Elm.; it is, however, very different from these three species. Its extra-Philippine allies are apparently *Litsea myristicaefolia* Hook. f. and *L. teysmanni* Gamble.

LITSEA AMPLA sp. nov.

Arbor usque ad 20 m alta subtus foliis ad costa nervisque partibus junioribusque pallide fulvo-villosis; foliis alternis, late ellipticis ad subobovatis, coriaceis, usque ad 30 cm longis, apice obtusis ad breviter abrupte acuminatis, basi late rotundatis, nervis utrinque circiter 20, subtus valde prominentibus, reticulis primariis prominentibus, subparallelis; fructibus e ramulis defoliatis, fasciculatis, pedicellis ferrugineo-pubescentibus, calycibus accrescentibus, circiter 7 mm diametro.

A tall tree, the branches terete, smooth, brownish, glabrous, the branchlets densely pale fulvous-pubescent with short hairs, the same type of indumentum on the petioles, the lower surfaces of the leaves, and the peduncles. Leaves alternate, broadly ellip-

tic to subobovate, coriaceous, 20 to 30 cm long, 11 to 17 cm wide, base broadly rounded, apex obtuse to abruptly and shortly acuminate, the upper surface somewhat olivaceous when dry, smooth and shining, glabrous, or the midrib very slightly pubescent, the lower surface a little paler than the upper, distinctly and shortly pubescent on the midrib, the lateral nerves, and the primary reticulations, the indumentum pale-fulvous, dense on the midrib and primary nerves; lateral nerves about 20 on each side of the midrib, very prominent on the lower surface, spreading-curved, the primary reticulations lax, prominent, subparallel; petioles 2.5 to 3.5 cm long, densely pubescent. Flowers on the branches below the leaves, fascicled in the axils of fallen leaves, the peduncles up to at least 10 in each fascicle, stout, about 8 mm long, densely pale fulvous-pubescent, each bearing at its apex from 1 to 3 sessile, young fruits. Calyx accrescent, in young fruit about 7 mm long, 7 mm in diameter at the apex, truncate, externally very slightly pubescent, dark brown, gradually narrowed to the base. Very young fruits oblong-obovoid, about 1 cm long, glabrous, dark brown, wrinkled, and shining when dry.

SAMAR, *Phil. Pl. 1654 Ramos*, April, 1914 (type). LUZON, Isabela Province, Ilagan, *For Bur. 20866 Bernardo*, Oct. 2, 1913, locally known here as *baticuling*.

A species belonging in the group with *Litsea philippinensis* Merr., but very distinct from that form in its much larger leaves which are prominently pubescent beneath.

LITSEA DOLICHOPHYLLA sp. nov.

Arbor circiter 18 m alta subtus foliis ramulis petioliisque dense fulvo-villosis; foliis subverticillatis, oblongis, coriaceis, usque ad 55 cm longis, utrinque subaequaliter angustatis, basi acutis, apice acuminatis, nervis utrinque circiter 14, subtus valde prominentibus; fructibus in ramis defoliatis, fasciculatis, breviter pedicellatis, ellipsoideis ad obovoideis, circiter 1.5 diametro, ut videtur extus carnosis, in siccitate nigris, nitidis, calycibus accrescentibus, leviter pubescentibus, circiter 8 mm diametro.

A tree about 18 m high, the branches terete, brown-pubescent, the younger parts densely so. Leaves subverticillate, oblong, 35 to 55 cm long, 9 to 13 cm wide, coriaceous, subequally narrowed to the acute base and the rather sharply acuminate apex, the upper surface brownish-olivaceous, smooth, glabrous, and shining when dry, the lower surface densely and softly fulvous-villous, the indumentum on the midrib and lateral nerves denser and darker in color than on the surface; lateral nerves about

14 on each side of the midrib, very prominent, ascending, somewhat curved, joining the somewhat thickened and revolute margins, the primary reticulations lax, subparallel, distinct; petioles stout, 3.5 to 6 cm long, densely brown-villous. Flowers not seen. Fruits fascicled along the branches below the leaves, usually three or four in a fascicle, the pedicels very stout, 2 to 4 mm long, glabrous or nearly so, the accrescent calyx shallow, brown when dry, very sparingly pubescent, about 8 mm in diameter, thickly coriaceous. Fruits red when mature, ellipsoid to obovoid, when fresh the pericarp apparently somewhat fleshy, when dry about 1.5 cm in diameter, nearly black, wrinkled, somewhat shining, glabrous.

SAMAR, Cauayan Valley, *Bur. Sci. 17540 Ramos*, March 27, 1914, in damp forests.

A very striking species, apparently belonging in the group with *Litsea tayabensis* Elm. Its elongated, coriaceous, large leaves, which are glabrous and shining on the upper surface and densely brown- to fulvous-villous on the lower surface, are very characteristic.

LITSEA EUPHLEBIA sp. nov.

Arbor circiter 12 m alta ramulis petiolis inflorescentiisque exceptis glabra; foliis coriaceis, oblongis ad anguste oblongo-ellipticis, alternis, nitidis, utrinque angustatis, acuminatis, usque ad 18 cm longis; nervis utrinque 6 ad 9, adscendentibus, prominentibus; inflorescentiis axillaribus, ferrugineo-pubescentibus, involucris fasciculato-umbellatis, breviter pedunculatis, circiter 6-floris; fructibus ellipsoideis, circiter 2 cm longis, calycibus auctis, 1.5 ad 2 cm diametro.

A tree about 12 m high, the branchlets, petioles, and inflorescence ferruginous- or brown-pubescent, otherwise glabrous. Branches terete, reddish-brown or somewhat grayish. Leaves alternate, coriaceous, shining, oblong to narrowly elliptic-oblong, about equally narrowed at both ends, the apex acuminate, base acute, 12 to 18 cm long, 3 to 5.5 cm wide, the lower surface somewhat paler than the upper; nerves 6 to 9 on each side of the midrib, very prominent on the lower surface, curved-ascending, obscurely anastomosing, the ultimate reticulations not prominent but close, very obscurely pitted; petioles 1 to 1.5 cm long, at first pubescent, becoming glabrous. Involucres subumbellately fascicled, axillary, densely pubescent, the pubescent peduncles 2 to 3 mm long. Involucral bracts orbicular, concave, 3 to 4 mm in diameter. Flowers about 6 in each involucre, the calyx-tube somewhat urceolate, pubescent, 4 mm long, the lobes deciduous, oblong, about 1.3 mm long. Male flowers not seen. Fruit ellip-

soid, smooth, about 2 cm long, seated on the enlarged, cup-shaped calyx, which is 1.2 to 2 cm in diameter and about 1 cm high.

LUZON, Laguna Province, near San Antonio, *Bur. Sci. 13523 Ramos*, (type), August, 1910, *For Bur. 15360 Tamesis*, November, 1909.

A species well characterized by its very prominently nerved leaves, but which may, when male flowers are known, prove to belong in the genus *Lindera* rather than in *Litsea*.

LITSEA MACGREGORII sp. nov.

Arbor, inflorescentiis exceptis glabra, ramis ramulisque teretibus; foliis alternis vel subverticillatis, oblongis, coriaceis, usque ad 16 cm longis, nitidis, subtus glaucescentibus, utrinque subaequaliter angustatis, basi acutis, apice obtusis, nervis utrinque circiter 10, adscendentibus, subtus valde prominentibus; umbellis pedunculatis, axillaribus et e axillis defoliatis, fasciculatis, 4- vel 5-floris, floribus pubescentibus, pedicellatis, bracteis involucrantibus caducis.

A tree, glabrous except the inflorescence, the branches and branchlets nearly black when dry, terete, smooth. Leaves alternate or subverticillate, oblong, coriaceous, 13 to 16 cm long, 3 to 4.5 cm wide, subequally narrowed to the acute base and to the obtuse apex, the upper surface smooth and shining, brownish-olivaceous, the lower paler and more or less glaucous; lateral nerves about 10 on each side of the midrib, ascending, very prominent on the lower surface, nearly straight, the reticulations obscure; petioles 1.5 to 2 cm long, dark reddish-brown when dry. Umbels axillary and from the axils of fallen leaves, 4 to 6 in a fascicle, the peduncles 1.5 to 2 cm long, all parts rather densely pale-pubescent. Involucral bracts caducous. Flowers 4 or 5 in each umbel, the pedicels about 4 mm long, rather slender, pubescent. Perianth lobes about 4 mm long, elliptic, obtuse, concave, rather densely pale-pubescent. Fertile stamens 9, the anthers oblong, 2 mm long, the filaments somewhat pubescent, about 1 mm long, the glands about 0.6 mm in diameter.

BILIRAN, *Bur. Sci. 18493 McGregor*, May 22, 1914, in forests, altitude about 200 meters.

The specimens present male flowers only, and the species resembles *Litsea euphlebia* Merr. in vegetative characters, but differs from it and from *L. quercoides* Elm. in its comparatively long-peduncled umbels.

LITSEA MICRANTHA sp. nov.

Arbor, partibus junioribus subtus foliis inflorescentiisque minute pubescentibus exceptis glabra; foliis alternis, oblongis, chartaceis vel subcoriaceis, usque ad 8 cm longis, utrinque

subaequaliter angustatis, basi acutis, apice acutis vel breviter acuminatis, nervis utrinque circiter 10; umbellulis axillaribus, parvis, tenuiter pedicellatis, fasciculatis vel in racemis brevissimis dispositis, circiter 4-floris, floribus 3 mm longis, filamentis ciliatis.

A tree, nearly glabrous, the branches and branchlets very slender, terete, smooth, grayish-brown, the ultimate ones about 1 mm in diameter and minutely appressed pubescent with short hairs. Leaves alternate, in general oblong, chartaceous to subcoriaceous, brown or brownish-olivaceous when dry, glabrous, the lower surface slightly paler than the upper and very minutely pubescent, 5 to 8 cm long, 1.5 to 2.5 cm wide, subequally narrowed to the acute base and to the acute or slightly acuminate apex; lateral nerves about 10 on each side of the midrib, slender, distinct on the lower surface, curved, the reticulations not prominent; petioles slender, 4 to 5 mm long. Umbels mostly 4-flowered, axillary, fascicled or in very short racemes, the pedicels slender, slightly pubescent, 4 to 5 mm long, the umbels, before anthesis, somewhat depressed-globose, 2 to 2.5 mm in diameter. Bracts 4, very slightly pubescent externally, broadly ovate, concave, rounded, 2 to 2.5 mm long. Male flowers about 3 mm long, the segments 6, oblong, 1.3 to 1.5 mm long, the tube appressed fulvous-pubescent including also the 1 mm long pedicels. Fertile stamens 9, all 4-celled, introrse, the outer ones 2.5 to 3 mm long, their filaments slender, ciliate.

SAMAR, *Bur. Sci. 17505 Ramos*, April 3, 1914, in forests at low altitudes.

A species belonging in the group with *Litsea luzonica* F.-Vill., well characterized by its comparatively small flowers and umbels.

LITSEA OBLONGIFOLIA sp. nov.

Arbor circiter 8 m alta, inflorescentiis exceptis glabra; foliis oblongis vel anguste oblongis, alternis, coriaceis, utrinque subaequaliter angustatis, acutis vel leviter acuminatis, nitidis, nervis utrinque 8 ad 11, curvato-adscendentibus, prominentibus, reticulis tenuibus, densis; inflorescentiis subumbellato-fasciculatis, dense brunneo-pilosis, involucris in alabastro globosis, circiter 5-floris; antheris 12, introrsis.

A tree about 8 m high, glabrous except the inflorescence. Branches terete, dark when dry. Leaves alternate, oblong to narrowly oblong, 18 to 30 cm long, 4 to 7 cm wide, subequally narrowed and acute or slightly acuminate at both ends, coriaceous, shining when dry, the lower surface paler than the upper one; nerves 8 to 11 on each side of the midrib, curved-ascending, prominent, obscurely anastomosing, the ultimate reticulations

slender, dense; petioles 1.5 to 2 cm long. Involucres in axillary, solitary, subumbellate fascicles, the peduncles and bracts densely brown-pilose, the peduncles 5 to 10 mm long. Involucral bracts usually 4, in nearly mature bud about 4 mm in diameter, concave, orbicular. Flowers about 5 in each head, pubescent. Fertile anthers 12, all introrse.

LUZON, Cagayan Province, Abulug River, *Bur. Sci. 14518 Ramos*, February, 1912, in forests.

A fruiting specimen from the same locality, *Bur. Sci. 13902 Ramos*, presumably represents the same species, but has relatively somewhat broader leaves, and its lateral nerves are more spreading. The accrescent calyx is funnel-shaped, about 1.5 cm long, 1 cm wide, and the fruit is subglobose or depressed-globose, apparently somewhat fleshy, black when dry, 2 cm in diameter.

Apparently closely allied to *Litsea albayana* Vid., but differing especially in its fine, close ultimate reticulations, which in Vidal's species are very obscure or nearly obsolete.

LITSEA SAMARENSIS sp. nov.

Arbor circiter 12 m alta, ramulis junioribus et subtus foliis minute pubescentibus; foliis alternis, oblongo-obovatis, subcoriaceis, usque ad 35 cm longis, apice late rotundatis vel abrupte brevissime acuminatis, basi acutis, nervis utrinque circiter 18, subtus prominentibus; fructibus e ramis defoliatis, solitariis vel fasciculatis, ovoideis, 2 to 3 cm longis, calycibus accrescentibus infundibuliformibus, circiter 1.5 cm longis 1 cm diametro.

A tree about 12 m high, the younger branchlets, petioles, and lower surfaces of the leaves minutely pubescent with short, rather pale hairs. Branches terete, glabrous, smooth, about 1 cm in diameter, the branchlets much more slender, slightly pubescent. Leaves alternate, sometimes somewhat crowded toward the apices of the branchlets, oblong-obovate, subcoriaceous, 22 to 35 cm long, 12 to 18 cm wide, the apex broadly rounded to abruptly and shortly acuminate, base acute, the upper surface olivaceous, shining, the lower somewhat paler, minutely cinerous-pubescent on the midribs, nerves, and reticulations; lateral nerves about 18 on each side of the midrib, prominent, spreading-curved, the primary reticulations subparallel, prominent on the lower surface, the ultimate reticulations shallowly foveolate on both surfaces; petioles rather slender, 4 to 6 cm long, nearly black when dry, sparingly cinereous-pubescent. Fruits on the branches below the leaves, solitary or somewhat fascicled, the peduncles stout, brown, glabrous, about 1 cm long, the accrescent calyx funnel-shaped, about 1.5 cm long and 1 cm in diameter at the apex, truncate,

narrowed below, thick, brown, much wrinkled when dry. Fruit ovoid, 2 to 3 cm long, apparently dark-red and somewhat fleshy when fresh, when dry black, shining, wrinkled, glabrous, obtuse or rounded at the apex.

SAMAR, Cauayan Valley, *Bur. Sci. 17541 Ramos*, March 24, 1914, on forested slopes.

Very distinct from *Litsea ampla* Merr. which it somewhat resembles; among the distinguishing characters are its differently shaped leaves, which are acute at the base, much longer petioles, and much larger fruits and calyces.

LITSEA VANOVERBERGHII sp. nov.

Arbor 5 ad 6 m alta ramulis junioribus et inflorescentiis exceptis glabra; foliis alternis, oblongis ad oblongo-ellipticis, coriaceis, usque ad 9 cm longis, utrinque subaequaliter angustatis, basi acutis, apice obtusis at leviter acuminatis, nervis utrinque 8 vel 9, reticulis obscuris; umbellis axillaribus, fasciculatis, circiter 6-floris, pedicellatis, floribus dense pubescentibus, 4 ad 5 mm longis; fructibus anguste ovoideis, acutis, circiter 2.5 cm longis, calycibus accrescentibus, hypocrateriformibus, 1 cm diametro.

A tree, apparently dioecious, 5 to 6 m high, glabrous except the inflorescence and the very youngest branchlets. Branches grayish-brown or brownish, terete, 3 to 4 mm in diameter, the young branchlets minutely cinereous-puberulent. Leaves alternate, oblong to oblong-elliptic, thickly coriaceous, 6 to 9 cm long, 2.5 to 4 cm wide, subequally narrowed to the acute base and to the obtuse, acute, or obscurely acuminate apex, brownish or brownish-olivaceous on the upper surface, somewhat shining, the lower surface paler; lateral nerves 8 or 9 on each side of the midrib, prominent, curved, not or very obscurely anastomosing, brown when dry, the reticulations obscure, both surfaces minutely and very shallowly foveolate, the upper more distinctly so than the lower; petioles glabrous, brown, about 8 mm long. Umbels axillary, fascicled, 3 to 6 in a fascicle, the peduncles appressed-pubescent, 4 to 5 mm long. Bracts 4, ovate to broadly ovate, concave, rounded, slightly pubescent externally, about 4 mm long. Flowers usually 6 in each umbel, 4 to 5 mm long, the tube somewhat urceolate, appressed-pubescent, somewhat narrowed below, the lobes 6, subequal, obtuse to acute, ovate to oblong-ovate, 1.5 mm long or less. Staminodes 6, in two series, the inner three about 1.2 mm long, linear-lanceolate, 0.2 mm wide, with two prominent, lateral, stipitate, capitate glands at the base, the outer three staminodes linear-lanceolate to linear-oblanceolate, without appendages, the lower part pro-

minently ciliate. Ovary ovoid, glabrous; style about 2 mm long. Fruit narrowly ovoid, about 2.5 cm long, apex acute, the accrescent calyx salver-shapped, the tube subcylindric, stout, about 5 mm long, the limb spreading, about 1 cm in diameter.

LUZON, Bontoc Subprovince, Bauco, *Vanoverbergh 1737*, November 8, 1912, in forests, altitude about 1,700 meters.

I have some doubt as to the genus of this species, although it is probably a *Litsea*. The species is apparently dioecious, as a careful examination of very many flowers failed to show a single one with fertile stamens.

LITSEA ALBAYANA Vid. Rev. Pl. Vasc. Filip. (1886) 227.

LUZON, Albay Province, *Vidal 860* (type), *1681*, in Herb. Kew. LEYTE, *For Bur. 12784 Rosenbluth*. I am disposed also to refer here *Cuming 894* from Albay Province, Luzon, on which is based the Philippine reference of *Lindera reticulata F.-Vill.*, and *For. Bur. 7317 Everett*, *For. Bur. 15148 Tarrosa*, from Negros.

The species is an imperfectly known one and may just as well be referable to *Lindera* as to *Litsea*, for the flowers are as yet unknown. Meissner[2] referred *Cuming 894* to *Aperula reticulata* Blume (*Lindera reticulata* F.-Vill.). I have examined the type of Blume's species in the Leiden Herbarium, and it is a plant entirely different from that represented by *Cuming 894;* the reference of Cuming's plant to Blume's species was a manifest error on the part of Meissner.

PHOEBE Nees

PHOEBE GLABRIFOLIA sp. nov.

Arbor usque ad 18 m alta, partibus junioribus inflorescentiisque exceptis glabra; foliis oblongo-obovatis, coriaceis, usque ad 22 cm longis, apice obtusis ad latissime breviter et obtuse acuminatis, deorsum angustatis, basi acutis, nervis utrinque circiter 8, subtus valde prominentibus; paniculis axillaribus, longe pedunculatis, usque ad 18 cm longis, floribus circiter 6 mm diametro.

A tree 15 to 18 m high, glabrous or nearly so except the younger parts and the inflorescence. Branches terete, brownish, rather stout, often with numerous rather large petiolar scars, glabrous, the younger parts sparingly pubescent. Leaves somewhat crowded at the apices of the branchlets, oblong-obovate, rather thickly coriaceous, 12 to 22 cm long, 5 to 8 cm wide, the upper surface brownish-olivaceous when dry, glabrous, shining, the lower slightly paler, rarely somewhat glaucous, glabrous or very minutely and obscurely puberulent, the apex obtuse to very broadly, shortly, and bluntly acuminate, narrowed below to the acute base; lateral nerves about 8 on each side of the midrib, very prominent on the lower surface, looped-anastomosing, the reticulations prominent; petioles 1.5 to 2 cm long. Panicles axillary,

[2] DC. Prodr. 15[1] (1864) 243.

long-peduncled, up to 18 cm long, the peduncles very slightly pubescent, the flower bearing parts rather prominently grayish-pubescent, flowers about 6 mm in diameter, the bracteoles oblong, acute to acuminate, about 2.5 mm long, pubescent. Perianth-lobes broadly ovate, 3.5 to 4 mm long, obtuse, pubescent. Other two rows of stamens with introrse anthers, about 2.5 mm long, the filaments slightly pubescent, the third row of stamens about 2 mm long, extrorse, each filament with a pair of stipitate, subcapitate glands near the base. Staminodes (fourth row) heart-shaped, about 1 mm long, on stout short stipes. Ovary globose, glabrous; style about 1.5 mm long. Fruit narrowly ovoid, about 1.5 cm long (immature), smooth, black and shining when dry, the perianth-lobes somewhat accrescent and 6 to 7 mm long, brown, short-pubescent, persistent.

BASILAN, *For. Bur. 18894 Miranda*, August, 1912 (type), *Bur. Sci. 16159, 16158 Reillo*, August, 1912, in forests along Comalarang River.

This species is manifestly very closely allied to *Phoebe cuneata* Blume, but appears to differ from it in its leaves being quite glabrous on both surfaces or at most very obscurely puberulent on the lower surface.

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NEW PHILIPPINE MYRSINACEAE

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In the present paper eighteen apparently new species of Philippine *Myrsinaceae* are described in the genera *Ardisia, Discocalyx,* and *Maesa.* Perhaps the most interesting fact brought out by the present contribution is the great increase in the number of known species of the genus *Discocalyx.* When Mez proposed this genus in 1902, he described eight species, of which six were from the Philippines, one from the Marianne Islands, and one from the Tonga Islands. Since that date numerous new forms have been detected in our current Philippine collections, and the number of species now known from the Philippines, including the nine described in the present paper, approximates twenty-seven.

DISCOCALYX Mez

DISCOCALYX ANGUSTISSIMA sp. nov.

Frutex glaber, circiter 1 m altus; foliis numerosis, linearis, usque ad 25 cm longis et 1 cm latis, olivaceis, nitidis, tenuiter acuminatis, basi attenuatis, margine distanter acute serratis; inflorescentiis axillaribus, tenuibus, longissime pedunculatis, foliis subaequantibus; floribus paucis, 5-meris; fructibus ovoideis, circiter 6 mm diametro.

A glabrous shrub about 1 m high, simple or sparingly branched, the branches terete, reddish-brown, 3 to 6 mm in diameter. Leaves numerous, linear, 20 to 25 cm long, 6 to 10 mm wide, chartaceous, olivaceous, shining, slenderly acuminate, base attenuate, margins rather distantly but conspicuously and acutely serrate; lateral nerves numerous, not prominent. Inflorescences few, very slender, axillary, about as long as the leaves, simple, the greately elongated peduncles supplied with few, scattered, linear-lanceolate, slenderly acuminate, leaf-like, 1 to 2 cm long

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bracts, the apical 1 cm usually thickened, brown, marked with numerous scars of fallen bracts or bracteoles and pedicels, in fruit each bearing 1 to 2, slender, jointed pedicels 3 to 4 cm in length. Fruits ovoid, about 6 mm in diameter, with distinct but shallow longitudinal grooves, the persistent sepals 5, ovate-lanceolate, acuminate, about 1 mm long.

ALABAT, *Merrill 10478* (type), December 24, 1916, on forested ridges, altitude about 75 meters. LUZON, Tayabas Province, Mauban, *Bur. Sci. 19480 Ramos*, January 25, 1913, on forested slopes: Laguna Province, Mount Bucol back of Santa Maria Mavitac, *For. Bur. 8897 Curran* (sterile), February, 1908.

A most characteristic species not at all closely allied to any other known form, readily recognizable by its greatly elongated, very narrow, distantly but conspicuously serrate leaves. It is apparently very local. On Alabat Island but a few individuals were observed, and these all confined to a small area.

DISCOCALYX EUPHLEBIA sp. nov.

Frutex 3 ad 4 m altus, glaber, ramulis circiter 1 cm diametro; foliis ellipticis ad oblongo-ellipticis, in siccitate brunneis, nitidis, usque ad 40 cm longis, breviter acuminatis, basi plus minusve acuminatis, margine distincte dentatis vel crenato-dentatis, nervis utrinque circiter 20, supra impressis, subtus valde prominentibus, utrinque maculis nigris conspicuis instructis; paniculis ♂ usque ad 15 cm longis, e ramulis specialibus circiter 10 cm longis extra-axillaribus supra valde incrassatis cicatricibus multis instructis; floribus 5-meris, prominente glandulosis, circiter 2.5 mm diametro.

A glabrous dioecious shrub 3 to 4 m high, the ultimate branches terete, about 1 cm thick, with few, very large scars of fallen petioles. Leaves brown and shining when dry, elliptic to oblong-elliptic, 35 to 40 cm long, 10 to 13 wide, both surfaces with conspicuous, nearly black, gland-like areas, usually one in each ultimate reticulation, subcoriaceous, the apex shortly acuminate, base somewhat acuminate, the margins, except in the lower part, with distinct dentate or dentate-crenate teeth; lateral nerves about 20 on each side of the midrib, impressed on the upper surface, very prominent beneath, the reticulations distinct; petioles 4 to 5 cm long. Staminate panicles up to 15 cm long, usually 6 to 8 at the apex of the specialized branch bearing them, these specialized branches up to 10 cm long, the upper 2.5 to 4 cm cylindric, thicker than the peduncular portions, 5 to 7 mm in diameter, and marked with numerous scars of fallen bracts and peduncles, the specialized branches extra-axillary; rachis and branches of the panicles slender. Flowers very shortly pedicel-

led, 5-merous, about 2.5 mm in diameter. Sepals nearly free, oblong-obovate or oblong, about 1.2 mm long, with few, conspicuous, dark-brown glands. Petals oblong, obtuse, 1.5 mm long, prominently glandular, nearly free. Anthers sessile, 0.5 mm long.

SAMAR, Paranas, *Bur. Sci. 17646 Ramos*, April 11, 1914, in damp forests at low altitudes.

The alliance of this species is manifestly with *Discocalyx insignis* Merr. from which it is distinguished by its conspicuously maculate leaves and its much longer staminate panicles. Other species belonging in the same group are *Discocalyx congestiflora* Elm., *D. longifolia* Merr., *D. montana* Elm., and *D. macrophylla* Merr. *Discocalyx maculata* Merr., among other characters, is at once distinguished by its entire leaves.

DISCOCALYX LUZONIENSIS sp. nov.

Frutex glaber, ramis ramulisque teretibus, ramulis circiter 5 mm diametro; foliis sparsis, coriaceis, nitidis, oblongis ad oblongo-ellipticis, integris, acutis, usque ad 9 cm longis, obscure maculatis, nervis primariis utrinque circiter 8, irregularibus, subtus distinctis, anastomosantibus; ramis specialibus extra-axillaribus, usque ad 12 cm longis, partibus superioribus incrassatis, cicatricibus distinctis instructis; paniculis depauperatis, circiter 1 cm longis; floribus ♂ 5-meris, pedicellis et sepalis et petalis prominente glandulosis.

A glabrous dioecious shrub, the branches and branchlets rather stout, terete, grayish-brown when dry, with few, widely scattered, large scars of fallen petioles, the ultimate branchlets about 5 mm in diameter. Leaves scattered, coriaceous, entire, rather pale when dry, shining, oblong to oblong-elliptic, 8 to 9 cm long, 3 to 4 cm wide, acute, base acute or acuminate, both surfaces obscurely maculate; primary lateral nerves about 8 on each side of the midrib, distinct on the lower surface, somewhat curved, irregular, distinctly anastomosing, the secondary veins nearly as prominent as the primary ones, the reticulations evident on both surfaces; petioles rather stout, 3 to 4 cm long. Specialized branches bearing the inflorescences extra-axillary, 8 to 12 cm long, the apical 1 to 2 cm thickened, cylindric, about 3 mm in diameter, marked with distinct scars of fallen bracts, the peduncle often dichotomous and bearing two thickened cylindric, parts at the apex. Inflorescences at the tips of the specialized branches, depauperate, about 1 cm long, few-flowered. Staminate flowers 5-merous; the pedicels, calyces, and corollas prominently glandular. Pedicels 1 to 2 mm long. Calyx 2.2 mm in diameter, the teeth 5, ovate, obtuse, 0.7 mm long. Corolla 1.8 mm long, the lobes ovate or oblong-ovate, rounded, 0.9 mm long.

Anthers sessile, 0.4 mm long. Rudimentary ovary stout, cylindric, about 1 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26474 Ramos & Edaño*, August 16, 1916, on forested slopes, altitude between 300 and 400 meters.

The alliance of this species is apparently with *Discocalyx maculata* Merr., from which it is readily distinguished by its much smaller, fewer-nerved, obscurely maculate leaves. The specialized branches bearing the inflorescences are frequently dichotomous, bearing two cylindric, thickened branches at their apices.

DISCOCALYX MICRANTHA sp. nov.

Frutex erectus, glaber, circiter 2 m altus; foliis chartaceis, oblongis, longe petiolatis, usque ad 18 cm longis, olivaceis, apice breviter acuminatis, basi decurrento-acuminatis, integris, nervis utrinque circiter 20, tenuibus, subadscendentibus; paniculis axillaribus, tenuibus, solitariis, circiter 10 cm longis, longe pedunculatis; floribus minutis, pedicellatis, 5-meris, calycibus petalisque distincte glanduloso-puncticulatis, petalis obovatis, circiter 1.2 mm longis.

An erect glabrous shrub about 2 m high, apparently dioecious, the branches subolivaceous, about 5 mm in diameter, longitudinally wrinkled when dry, the tips brown. Leaves somewhat crowded toward the apices of the branchlets, chartaceous, oblong, 14 to 18 cm long, 3.5 to 5 cm wide, subolivaceous when dry, slightly shining, of the same color on both surfaces, entire, the apex shortly acuminate, base slenderly decurrent-acuminate; lateral nerves slender, the primary ones about 20 on each side of the midrib, subascending, slightly curved, the reticulations not prominent; petioles 1.5 to 3 cm long. Panicles bipinnate, axillary, solitary, up to 10 cm long, long peduncled, the branches few, the longer primary ones 1.5 to 2.5 cm in length. Staminate flowers 5-merous, their pedicels about 1 mm long. Calyx about 1.5 mm in diameter, obscurely 5-toothed, distinctly glandular-puncticulate, the teeth short, obtuse, minutely denticulate or subcrenate. Petals obovate, 1.2 mm long, glandular-puncticulate. Anthers 0.7 mm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27132 Ramos*, March 12, 1917, in forests along streams at low altitudes.

The alliance of this species is manifestly with *Discocalyx cybianthoides* Mez, which it resembles in its general appearance, in leaf characters, and in its panicles springing from the axils of normal leaves, differing essentially in its very much smaller flowers.

DISCOCALYX PACHYPHYLLA sp. nov.

Frutex dioicus, glaber, circiter 5 m altus; foliis numerosis,

plus minusve confertis, coriaceis, oblongo-oblanceolatis vel anguste oblongo-ovatis, integris, usque ad 18 cm longis, in siccitate brunneis, nitidis, acutis vel leviter acuminatis, basi acutis; inflorescentiis e ramis specialibus, paniculis ♂ confertis, junioribus circiter 4 cm longis bracteis glandulosis membranaceis usque ad 2 cm longis ovato-ellipticis deciduis involucratis; floribus parvis, 4- vel 5-meris, glandulosis.

A dioecious glabrous shrub about 5 m high, the branches and branchlets terete, brown, the latter usually about 5 mm in diameter, usually with numerous close scars marking the limits of the past seasons growth, the leaves numerous, rather crowded. Leaves rather thickly coriaceous, entire, pale-brownish, shining and of the same color on both surfaces when dry, not glandular but beneath very obscurely puncticulate, oblong-oblanceolate to narrowly oblong-obovate, apex acute or somewhat acuminate, narrowed from the upper one-half to two-thirds to the cuneate base; primary lateral nerves about 8 on each side of the midrib, irregular, ascending, scarcely more prominent than are the secondary nerves and reticulations; petioles stout, 4 to 5 cm long. Staminate panicles on specialized extra-axillary branches, these branches 4 to 8 cm long, rather stout, the upper 0.5 to 2 cm thickened, cylindric, marked with numerous scars of fallen bracts, the bracts subtending and enclosing the young panicles brown when dry, membranaceous, prominently glandular, ovate-elliptic, obtuse or rounded, deciduous. Panicles crowded at the apices of the specialized branches, up to 4 cm long, probably longer when mature. Flowers numerous, small, in bud globose, 4- or 5-merous, both calyx and corolla prominently glandular.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 20729, 20766, 20830 Escritor*, March, 1913, the last two numbers erroneously localized on the herbarium labels as Guinayangan.

A species well characterized by its numerous, thickly coriaceous, entire, shining leaves; and its rather dense panicles, which are crowded at the apices of the specialized branches and subtended by large, membranaceous, glandular bracts, these forming an involucre at the apex of the branch below the panicles. On two of the specimens cited above there are one or two greatly reduced, 3 to 5 cm long, coriaceous leaves on the specialized branches, as is the case with a few other species of the genus.

DISCOCALYX SAMARENSIS sp. nov.

Frutex dioicus, glaber, circiter 5 m altus; foliis numerosis, pseudoverticillatis, oblanceolatis, integris, usque ad 14 cm longis, in siccitate pallidis, subcoriaceis, margine leviter revolutis, acutis vel obscure acuminatis, deorsum sensim angustatis, nervis utrinque circiter 12, tenuibus, adscendentibus; paniculis ♂ axillaribus,

bipinnatis, foliis subaequantibus; floribus 5-meris, circiter 4 mm longis.

A dioecious glabrous shrub about 5 m high, the branches brownish, smooth, 4 to 5 mm in diameter. Leaves pseudo-verticillate, oblanceolate, 11 to 14 cm long, 1.6 to 2 cm wide, entire, margins slightly revolute, acute or obscurely acuminate, gradually narrowed below to the stout petiole, pale and shining when dry, of about the same color on both surfaces; primary nerves about 12 on each side of the midrib, slender, ascending; petioles 5 mm long or less. Staminate panicles axillary, bipinnate, about as long as the leaves, the peduncles and lower branches 3 to 4 cm in length. Flowers white, 5-merous, their pedicels about 4 mm long. Calyx subrotate, about 3 mm in diameter, usually eglandular, the teeth triangular-ovate, obtuse or subacute, less than 1 mm long. Corolla 4 mm long, the lobes oblong, obtuse, about 2.5 mm long, with a few conspicuous glands above, united for the lower 1.5 mm. Stamens 5, the anthers oblong, sessile, obtuse, the connectives eglandular. Rudimentary ovary thickened upward, truncate, 1.7 mm long.

SAMAR, San José de Buan, along streams, altitude about 300 meters, *For. Bur. 24004 Lasquety*, May 7, 1915.

A species manifestly allied to *Discocalyx cybianthoides* Mez, from which it is distinguished by its much smaller, narrower leaves and much larger flowers.

DISCOCALYX STENOPHYLLA sp. nov.

Frutex glaber, circiter 4.5 m altus, dioicus; foliis oblongo-lanceolatis ad oblongo-lanceolatis, subcoriaceis, pallidis, nitidis, integris, usque ad 15 cm longis, obtusis vel obscure acuminatis, basi angustatis, nervis utrinque circiter 15, tenuibus, utrinque reticulatis; paniculis ♂ subterminalibus, usque ad 12 cm longis, bipinnatis; floribus 3- vel 4-meris, eglandulosis, circiter 2 mm longis.

A glabrous dioecious shrub about 4.5 m high. Branches terete, grayish or brownish, smooth, 2 to 3 mm in diameter. Leaves scattered or pseudo-verticillate, subcoriaceous, pale, shining, of the same color on both surfaces when dry, oblong-lanceolate to somewhat oblanceolate, entire, obtuse to obscurely acuminate, base gradually narrowed, cuneate; primary lateral nerves about 15 on each side, slender, irregular, not prominent, curved, anastomosing, the primary and secondary nerves and the reticulations evident on both surfaces; petioles stout, 4 to 6 mm long. Staminate panicles several in the uppermost axils, that is, subterminal, up to 12 cm long, bipinnate, slender, the primary branches scattered, spreading, the lower ones up to 3 cm long. Flowers

3- and 4-merous, eglandular, their pedicels 2.5 mm long. Calyx somewhat cup-shaped, about 1.7 mm in diameter, the teeth short, rounded. Corolla 2 mm long, the lobes 3 or 4, elliptic, rounded, about 1.2 mm long. Anthers oblong, 1 mm long, obtuse, the connectives glandular. Rudimentary ovary none.

LUZON, Pangasinan Province, Mangatarem, *For. Bur. 24815 Pascual*, November 23, 1915, among undergrowth in forests, altitude about 300 meters, locally known as *rocrocso*.

The alliance of this species is manifestly with Discocalyx *cybianthoides* Mez, from which it is readily distinguished by its much smaller, narrower leaves and eglandular flowers. From *D. samaransis* Merr. it is distinguished by its much smaller flowers. In general appearance it somewhat resembles *Discocalyx angustifolia* Mez, but the primary and secondary nerves and the reticulations are evident on both surfaces of the leaves.

DISCOCALYX SESSILIFOLIA sp. nov.

Arbor parva, glabra, omnibus partibus in siccitate brunneis, ramis ramulisque crassis, laevis, 5 ad 7 mm diametro; foliis subcoriaceis, anguste, oblongo-obovatis ad oblanceolatis, nitidis, usque ad 20 cm longis, obtusis vel obscurissime late et obtuse acuminatis, basi sensim angustatis, sessilibus, subtus obscurissime puncticulatis, nervis numerosis, vix prominentibus; paniculis ♂ bipinnatis, usque ad 10 cm longis, in ramis specialibus axillaribus 2 ad 3 cm longis dispositis; floribus 4-meris, circiter 4 mm longis, petalis sepalisque glandulosis.

A small tree, 8 m high according to the collector, glabrous, apparently dioecious, all parts brownish when dry, the branches and branchlets stout, smooth, terete, 5 to 7 mm in diameter. Leaves scattered, narrowly oblong-obovate to oblanceolate, entire, shining, of about the same color on both surfaces, 12 to 20 cm long, 3.5 to 6 cm wide, subcoriaceous, the lower surface obscurely puncticulate, the apex obtuse to broadly and obscurely blunt-acuminate, gradually narrowed in the lower one-half to two-thirds to the cuneate base, sessile; lateral nerves slender, not prominent, 15 to 20 on each side of the midrib, scarcely more prominent than the secondary nerves and reticulations. Special branches bearing the inflorescences in the axils of fallen leaves, 2 to 3 cm long, the upper part marked with prominent scars of fallen bracts and inflorescences, about 4 mm in diameter, somewhat thicker than the peduncular portions, the bracts deciduous, lanceolate to ovate-lanceolate, membranaceous, acuminate, about 1 cm long. Staminate panicles bipinnate, up to 10 cm long, the branches spreading, the lower ones up to 2.5 cm in length, usually about four panicles from the apex of each special branch. Staminate flowers 4-merous, about 4 mm long, their pedicels about

2 mm long. Calyx somewhat cup-shaped, nearly 2 mm in diameter, with four, short, rounded, obscure teeth, their margins somewhat crenulate, glandular. Corolla 4 mm long, glandular, the lobes oblong, obtuse, 2 mm long. Stamens 4, oblong, sessile, 1.2 mm long, the connectives black-glandular on the back. Rudimentary ovary and style rather stout, about 2 mm long.

MINDANAO, Agusan Subprovince, near Butuan, *For. Bur. 20735 Rafael & Ponce*, September 12, 1913, in swamp-forests at low altitudes.

A species manifestly allied to *Discocalyx merrillii* Mez and to *D. palawanensis* Elm., well characterized, however, by its sessile leaves and much larger flowers. The specialized branches bearing the inflorescences present no reduced leaves.

DISCOCALYX TECSONII sp. nov.

Arbor glabra, 5 ad 8 m alta; foliis breviter petiolatis, oblongo-oblanceolatis, usque ad 34 cm longis, chartaceis, acutis ad leviter acuminatis, integris, deorsum sensim angustatis, basi cuneatis, nervis utrinque circiter 20, distinctis; paniculis bipinnatis, usque ad cm longis, in ramis extra-axillaribus vel e exillis defoliatis dispositis, ramis specialibus compressis, 1 ad 3.5 cm longis supra plus minusve incrassatis cicatricibus et cum foliis depauperatis instructis; floribus ♂ 4- vel 5-meris, glandulosis, circiter 3 mm longis, petalis ad basi leviter connatis.

A glabrous tree 5 to 8 m high, apparently dioecious, the branches brown when dry, terete, about 5 mm in diameter. Leaves rather pale when dry, chartaceous, oblong-oblanceolate, entire, 20 to 34 cm long, 5 to 9 cm wide, apex acute to obscurely acuminate, gradually narrowed from about the upper two-thirds to the cuneate base; lateral nerves distinct, usually about 20 on each side of the midrib, irregular, anastomosing; petioles stout, about 5 mm long. Special branches bearing the inflorescences extra-axillary or from the axils of fallen leaves, usually compressed, 1 to 3.5 cm long, about 3 mm in diameter, their apices somewhat thickened and with the evident scars of fallen peduncles, bracts, and leaves, the panicles subtended by two or three greatly reduced leaves similar to the ordinary ones but from 4 to 9 cm long, the brown bracts membranaceous, lanceolate, acuminate, about 1 cm long, deciduous. Panicles up to 6 cm long, the branches 2 cm long or less. Flowers 4- or 5-merous, the staminate ones about 3 mm long. Calyx somewhat cup-shaped, nearly 2 mm in diameter, the teeth broad, rounded, entire, glandular. Corolla 3 mm long, the lobes oblong, obtuse, free nearly to the base, glandular. Anthers sessile, oblong, 1 mm long, the connectives glandular. Rudimentary ovary and

style about 1.5 mm long, cylindric, thickened upward. Young fruits globose, about 4 mm in diameter.

BASILAN, Tumakis, *For. Bur. 24683 Tecson* (type), November 4, 1915; Mount Singal, *For. Bur. 18977 Miranda*, October 1, 1912, both in forests, altitude 20 to 100 meters, said by Tecson to be common. MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 17984 Miranda*, in forests, altitude 10 meters.

This species is manifestly allied to *Discocalyx merrillii* Mez and to *D. sessilifolia* Merr., differing from both in the reduced leaves on the special branches bearing the inflorescences, these branches being much shorter than in *D. merrillii*, and in its staminate flowers being smaller than in *D. sessilifolia* Merr.

ARDISIA Swartz

ARDISIA SAMARENSIS sp. nov. § *Akosmos*.

Frutex, inflorescentiis parcissime furfuraceo-sublepidotis exceptis glaber; foliis alternis, lanceolatis ad oblongo-lanceolatis, utrinque subaequaliter angustatis, integris, basi acutis, apice distincte acuminatis, nervis lateralibus utrinque circiter 15, curvatis, anastomosantibus; paniculis axillaribus, circiter 8 cm longis, bracteis foliaceis circiter 5 mm longis, deciduis; floribus 5-meris, circiter 4 mm longis, sepalis petalisque parcissime glanduloso-puncticulatis.

A shrub about 2 m high, glabrous except the very sparingly furfuraceous-sublepidote inflorescences. Branches brownish, subterete, the branchlets more or less angled when dry. Leaves alternate, lanceolate to oblong-lanceolate, 17 to 20 cm long, 3 to 4.5 cm wide, subequally narrowed to the acute base and the rather prominently acuminate apex, entire, shining, greenish-olivaceous when dry, the glands blackish, scattered, evident on both surfaces, often to be found chiefly near the margins; lateral nerves about 15 on each side of the midrib, lax, curved, anastomosing, rather prominent on the lower surfaces, the reticulations distinct on both surfaces; petioles 1.5 to 2 cm long. Panicles axillary, peduncled, about 8 cm long, bipinnate, the primary branches few, spreading, up to 4 cm long, the greatly reduced leaf-like bracts about 5 mm long, deciduous. Flowers 5-merous, racemosely arranged on the ultimate branches, their pedicels 2 to 3 mm long. Sepals elliptic-ovate, obtuse, about 2 mm long, spreading, sparingly glandular-punctate, margins minutely ciliate. Petals elliptic-ovate, obtuse, about 4 mm long, slightly glandular-punctate. Anthers lanceolate, somewhat acuminate, 2.3 mm long, the connectives glandular.

SAMAR, *Pinipisakan, Bur. Sci. 24462 Ramos*, March 21, 1916, on steep forested slopes at low altitudes.

This species is manifestly allied to *Ardisia fragrans* Elm. and to *A. loheri* Merr., but is distinguished from both by numerous characters, the most evident one, perhaps, being the greatly reduced leaf-like bracts.

ARDISIA LOHERI sp. nov. § *Akosmos.*

Arbor parva, circiter 5 m alta, ramulis inflorescentiisque parcissime brunneo-furfuraceo-tomentellis exceptis glabra; foliis oblongis ad oblongo-ellipticis, usque ad 22 cm longis, utrinque subaequaliter angustatis, acuminatis, basi acutis, in siccitate pallide olivaceis, nervis utrinque 20 ad 25, subtus prominentibus, utrinque, saltem prope margine, punctis permanifestis instructis; inflorescentiis axillaribus, bipinnatim paniculatis, pedunculatis, usque ad 18 cm longis, multifloris; floribus racemose dispositis, 5-meris, circiter 3 mm longis, sepalis petalisque punctis paucis magnis instructis, connectivo glanduloso.

A small tree about 5 m high, the young branchlets and the inflorescences sparsely brown furfuraceous-tomentose, otherwise glabrous. Branches terete, pale brownish, the branchlets more or less angled. Leaves alternate, scattered, firmly chartaceous, usually pale olivaceous when dry, oblong to oblong-elliptic, subequally narrowed to the rather prominently acuminate apex and the acute base, 12 to 22 cm long, 3.5 to 6 cm wide, entire, the glands evident on both surfaces, but especially numerous near the margins; lateral nerves 20 to 25 on each side of the midrib, prominent on the lower surface, irregular, anastomosing, the secondary nerves and reticulations distinct; petioles 1.5 to 3 cm long. Panicles in the upper axils, bipinnate, peduncled, up to 18 cm long, many flowered, the primary branches up to 6 cm in length, the flowers racemosely arranged on the ultimate branchlets, their pedicels about 3 mm long. Flowers 5-merous. Sepals ovate, obtuse or acute, spreading, nearly free, about 1.5 mm long, with few, large, prominent glands, the margins obscurely ciliate. Petals elliptic-ovate, obtuse, 3 to 3.5 mm long, with few, scattered, prominent glands, rarely nearly eglandular. Anthers lanceolate, acuminate, 2.5 mm long, the connective distinctly glandular; style about 2 mm long.

LUZON, Rizal Province, Oriud, *Loher 6146* (type); Montalban, *Loher 6145*, both collected in February, 1906: Laguna Province, Mount Maquiling, *Baker 368*, October 27, 1912, *For. Bur. 22232* Catalan, March 28, 1914, *For. Bur. 21305 Foxworthy & Catalan*, May, 1914. On Mount Maquiling it grows in the mossy forest at an altitude of about 1,000 meters.

The alliance of this species is manifestly with *Ardisia fragrans* Elm., of Mindanao, from which it is distinguished by its thinner, larger, more numerously nerved leaves.

ARDISIA BASILANENSIS sp. nov. § *Acrardisia.*

Frutex, inflorescentiis minute papilloso-glandulosis exceptis glaber; foliis oblongo-ovatis, chartaceis, usque ad 18 cm longis, in siccitate supra subolivaceis, subtus brunneis, utrinque plus minusve glandulosis, acuminatis, basi acutis, nervis utrinque circiter 18, tenuibus, distinctis; paniculis usque ad 16 cm longis, terminalibus, pedunculatis, floribus in ramulis ultimis subumbellatim dispositis, brunneo-papilloso-glandulosis; floribus 5-meris, sepalis petalisque valde glandulosis, petalis ovatis, acuminatis, circiter 8 mm longis.

A shrub 3 to 4 m high, according to the collector; glabrous except for the short, rather dense, brown, gland-like papillae on the inflorescence. Branches and branchlets brownish, terete, smooth. Leaves oblong-ovate, chartaceous, entire, 11 to 18 cm long, 4.5 to 7.5 cm wide, somewhat shining, the upper surface olivaceous or subolivaceous, the lower brownish, both surfaces with scattered, distinct, black glands, but those near the margins no more distinct than the distant ones, apex acuminate, base acute; lateral nerves slender but distinct, the primary ones about 18 on each side of the midrib, anastomosing; petioles stout, about 5 mm long. Panicles terminal, up to 16 cm long, peduncled, the branches few, distant, spreading, the lower ones up to 5 cm long, simple or rarely once branched, the flowers subumbellately arranged at the ends of the branchlets, about 10 on each branchlet, their pedicels 8 to 10 mm long. Flowers pink, 5-merous, when spread nearly 1.5 cm in diameter. Sepals 5, the free parts ovate, acute or somewhat acuminate, spreading, 2 mm long, glandular-punctate, back and margins with the minute papillae characteristic of the inflorescence. Petals nearly free, ovate, sharply acuminate, prominently glandular-punctate, about 8 mm long, 4.5 mm wide. Anthers lanceolate, acuminate, 4 mm long, the connectives inconspicuously glandular. Ovary ovoid, glabrous, 2 mm long; style 4 mm long, shorter than the petals in bud and in anthesis.

BASILAN, Binauangan, in forests, *Bur. Sci. 15423* (type), *15437 Reillo*, August, 1912, the flowers pink.

This species is well characterized by its peculiar, dark-brown, minute, rather densely arranged gland-like papillae on its inflorescences. The flowers are distinctly large in comparison with the other Philippine species of the section *Acrardisia.*

ARDISIA LAXIFLORA sp. nov § *Acrardisia.*

Arbor glabra, circiter 11 m alta; ramis ramulisque plus minusve compressis, saltem leviter bicarinatis; foliis alternis, chartaceis,

oblongo-ovatis ad elliptico-ovatis, usque ad 14 cm longis, breviter petiolatis, apice obtuse acuminatis, basi acutis vel subacutis, utrinque glandulis multis permanifestis praeditis, nervis utrinque circiter 15, tenuibus, distinctis; paniculis terminalibus, usque ad 25 cm longis, diffusis, ramis ramulisque elongatis, ramis alternis, inferioribus usque ad 14 cm longis; floribus 5-meris, circiter 5 mm longis, longe pedicellatis, in ramulis ultimis racemose dispositis, petalis et sepalis et antheris prominente glandulosis.

A glabrous tree about 11 m high, the branches and branchlets somewhat compressed and distinctly bicarinate, the latter, together with the axis and the branches of the inflorescence, distinctly glandular-lineolate. Leaves alternate, chartaceous, oblong-ovate to ovate-elliptic, entire, 10 to 14 cm long, 3.5 to 5.5 cm wide, rather pale when dry, slightly shining, both surfaces with numerous dark-colored glands distinctly visible to the naked eye, apex blunt-acuminate, base acute or subacute; primary lateral nerves about 15 on each side of the midrib, slender, distinct, irregular, anastomosing; petioles 2 to 3 mm long or the leaves sometimes subsessile, the petiole and midrib glandular-punctate. Panicles terminal, diffuse, up to 25 cm long, tripinnate, the lower branches up to 14 cm long, these subtended by greatly reduced leaves 3 to 4 cm long, the primary branches few, spreading, the secondary ones few, 3 to 4 cm long, the flowers long-pedicelled, racemosely arranged on the upper one-fourth of the ultimate branchlets, the pedicels slender, up to 1.5 cm long. Flowers 5-merous. Calyx 4 mm in diameter, the lobes spreading, ovate, obtuse, 1.2 mm long, their margins slightly ciliate, below with black, above with reddish conspicuous glands. Petals oblong-ovate, acuminate, 5 mm long, 2 mm wide, conspicuously glandular-punctate. Anthers ovate-lanceolate, acuminate, 2.5 mm long, the entire back glandular; filaments flattened, stout, about 1 mm long. Ovary ovoid, 1.2 mm long, glabrous; style 3 mm long.

MINDANAO, Lanao District, Kolambugan, *For. Bur. 25907 Alviar*, June 8, 1916, along streams, altitude about 10 meters.

A most characteristic species, readily recognized by its conspicuous glands, which are distinctly visible to the naked eye, and its very lax, ample, terminal inflorescences. Its alliance is with *Ardisia leytensis* Merr.

ARDISIA MIRANDAE sp. nov. § *Acrardisia?*

Arbor circiter 5 m alta, glabra; foliis oblongo-ellipticis ad oblongo-obovatis, subcoriaceis, nitidis, plus minusve confertis, usque ad 8 cm longis, in siccitate brunneis, nitidis, subtus punctiulatis, apice brevissime late obtuseque acuminatis, basi acutis, nervis lateralibus obscuris, tenuibus, utrinque circiter 25; pani-

culis terminalibus vel subterminalibus, 3 ad 4 cm longis, pedunculatis, bipinnatis, paucifloris, foliis valde reductis subtensis; floribus 5-meris, in ramulis primariis subumbellatim dispositis, sepalis petalisque punctatis, petalis circiter 3 mm longis.

A tree about 5 m high, glabrous or the very young parts of the inflorescences obscurely brown papillose. Branches brownish, terete, with numerous petiolar scars. Leaves crowded near the apices of the branchlets but scarcely pseudo-verticillate, coriaceous, brown and shining when dry, entire, oblong-elliptic to oblong-obovate, apex very broadly and obscurely blunt-acuminate, base acute, the lower surface minutely puncticulate; lateral nerves very slender, obscure, about 25 on each side of the midrib; petioles dark brown when dry, 5 to 7 mm long. Panicles several on each ultimate branchlet, terminal or in the uppermost axils, 3 to 4 cm long, subtended by greatly reduced leaves or leaf-like bracts, the smaller ones about 1 cm in length. Flowers white, umbellately disposed on the primary branches, 5-merous, their pedicels about 5 mm long. Calyx 3 to 3.5 mm in diameter, the lobes orbicular, rounded, spreading, not imbricate, glandular-punctate, margins ciliate, about 1.5 mm in diameter. Petals ovate, obtuse, 3 mm long, glandular-punctate. Anthers lanceolate, acuminate, 2.5 mm long, the connectives glandular. Ovary ovoid; style 1.5 mm long.

LUZON, Camarines Province, Mount Calingan, *For. Bur. 21686 Miranda*, April 24, 1914, on the summit of a small peak in the mossy forest, altitude about 700 meters.

A very characteristic species, not certainly belonging in the section *Acrardisia*. It is characterized by its small, densely but obscurely nerved, crowded but scarcely pseudo-verticillate leaves, and by its panicles being subtended by reduced leaves or leaf-like bracts.

ARDISIA YATESII sp. nov. § *Pimelandra*.

Frutex 2 ad 4 m altus, novellis inflorescentiisque parce ferrugineo-pubescentibus exceptis glaber; foliis oblongis, chartaceis, in siccitate subolivaceis vel brunneis, nitidis, usque ad 17 cm longis, integris, basi acutis, apice tenuiter acute acuminatis, nervis utrinque circiter 15, subtus distinctis, pagina inferiore minutissime rufo-puncticulatis; infructescentibus axillaribus, solitariis, subumbellatis, petiolo subaequantibus, sepalis ovatis, glanduloso-puncticulatis, acutis, 2 mm longis, liberis vel subliberis, acutis, margine leviter ciliatis; fructibus globosis, glabris, circiter 7 mm diametro.

A shrub 2 to 4 m high, the very young growing tips of the branchlets and the infructescences somewhat ferruginous-pubes-

cent, otherwise glabrous. Branches pale-brownish, smooth, terete, the branchlets somewhat angled or compressed when dry. Leaves oblong, chartaceous, subolivaceous or brownish when dry, shining, the lower surface slightly paler then the upper, 10 to 17 cm long, 2 to 4.5 cm wide, entire, subequally narrowed to the acute base and to the slenderly acute-acuminate apex, the lower surface minutely brown-puncticulate with scattered glands; lateral nerves about 15 on each side of the midrib, distinct, anastomosing, slightly curved, the ultimate reticulations evident on both surfaces; petioles 1 to 1.5 cm long. Infructescences axillary, solitary, subumbellate, the peduncles about 8 mm long, the pedicels crowded toward its tip, sparingly ferruginous-pubescent, the pedicels, in friut, about 1 cm long, somewhat thickened upward. Calyx-lobes ovate, acute, distinctly glandular with reddish glands, about 2 mm long, nearly free, their margins minutely ciliate. Fruit globose, glabrous, smooth, about 7 mm in diameter, nearly black when mature.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25453* (type), *25494*, *25389 Yates*, December 14, 1916, on forested slopes, altitude 350 to 400 meters.

A species manifestly allied to *Ardisia philippinensis* A. DC. and *A. disticha* A. DC. but distinguished, among other characters, by its smaller, narrower, slenderly and sharply acuminate leaves.

ARDISIA TAYABENSIS sp. nov. § *Pyrgus*.

Frutex glaber, circiter 2 m altus; foliis oblongo-lanceolatis, usque ad 10 cm longis, integris, in siccitate brunneis, nitidis, utrinque subaequaliter angustatis, acutis vel obscure acuminatis, nervis primariis utrinque circiter 12, distinctis; paniculis terminalibus, sub fructu circiter 9 cm longis; fructibus ovoideis, circiter 8 mm longis obscure longitudinaliter striatis, sepalis glabris.

A glabrous shrub about 2 m high, the branches and branchlets brown, terete, smooth. Leaves crowded near the apices of the branches, subcoriaceous, brown and shining when dry, the lower surface slightly paler than the upper, oblong-lanceolate, 7 to 10 cm long, 2 to 2.5 cm wide, entire, subequally narrowed to the acute or slightly acuminate base and apex, both surfaces glandular-puncticulate; lateral nerves about 12 on each side of the midrib, distinct, the secondary nerves and reticulations distinct on both surfaces; petioles 8 to 14 mm long. Panicles terminal, in fruit about 9 cm long, the axis stout, the primary branches scattered, spreading, 1 to 1.5 cm long, the pedicels thickened upward, about 7 mm long. Fruits ovoid, about 8 mm long, obscurely longitudinally striate, brown, shining, the persistent se-

pals broadly ovate, obtuse, about 1 mm long, eglandular, their margins glabrous or obscurely ciliate.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26527 Ramos & Edaño,* September 10, 1916, in forests, altitude about 300 meters.

The alliance of this species is manifestly with *Ardisia whitfordii* Mez, from which it is distinguished by its very much smaller, narrower, fewer-nerved leaves.

ARDISIA PACHYPHYLLA sp. nov. § *Tinopsis.*

Frutex vel arbor parva, glabra, 2 ad 5 m alta; foliis coriaceis, oblongo-oblanceolatis ad anguste oblongo-obovatis, integris, usque ad 13 cm longis, leviter obtuse acuminatis, basi cuneatis, obscure puncticulatis, in siccitate brunneis, nervis tenuibus, utrinque circiter 25, subadscendentibus; inflorescentiis terminalibus, circiter 6 cm longis, floribus 5-meris, in ramulis subumbellatim dispositis, circiter 2 cm diametro; calycibus cupulatis, lobis latissime rotundatis, obscure ciliatis, distincte punctatis, haud imbricatis; petalis circiter 9 mm longis, punctatis, antheris haud puncticulatis.

A shrub or small tree 2 to 5 m high, glabrous, the branches and branchlets terete, smooth, brownish when dry. Leaves alternate, brown when dry, of the same color on both surfaces, somewhat shining, coriaceous, entire, oblong-oblanceolate to narrowly oblong-obovate, 9 to 13 cm long, 2.5 to 4.5 cm wide, narrowed below to the cuneate base, the apex obscurely blunt-acuminate, beneath obscurely puncticulate; lateral nerves slender, somewhat ascending, about 25 on each side of the midrib, anastomosing; petioles 8 to 10 mm long. Panicles terminal, stout, subpyramidal, up to 6 cm in length, the primary branches spreading, 1.5 to 2 cm long, the flowers rather densely subracemosely or subumbellately arranged toward the apices of the primary branches, their pedicels less than 10 mm long in anthesis, in fruit somewhat elongated. Calyx cup-shaped, coriaceous, about 5 mm long in anthesis, brown when dry, distinctly glandular-puncticulate, slightly accrescent, the lobes 5, broadly rounded, not or very obscurely imbricate, about 2 mm long, 2.3 to 3 mm wide, their margins minutely ciliate. Corolla in full anthesis about 2 cm in diameter, pink, the tube about 3 mm long, the lobes ovate, 7 to 9 mm long, about 6 mm wide, acute or acuminate, subcoriaceous, glandular-puncticulate. Anthers lanceolate, acuminate, 6 mm long, eglandular. Ovary ovoid, glabrous; style glandular-punctate, 6 mm long.

PALAWAN, Taytay, *Merrill 9216* (type) *9188*, April, 1913, in dry thickets and open grasslands, altitude 4 to 15 meters. BALABAC, *Bur. Sci. 21613 Escritor,* August, 1913, with immature fruits.

The alliance of this species is apparently with *Ardisia lanceolata* Roxb. from which it is distinguished by many characters especially in its slender, more numerous nerves, and much larger flowers; the prominent calyx-tube; and the calyx-lobes in bud and in anthesis scarcely overlapping, but in young fruit distinctly imbricate.

MAESA Forskål

MAESA MEGAPHYLLA sp. nov. § *Eumaesa.*

Frutex scandens, glaber; foliis late ovatis, crasse coriaceis, integris, usque ad 20 cm longis, obtusis vel late obtuseque acuminatis, basi rotundatis ad truncatis, nervis utrinque circiter 7, prominentibus; inflorescentiis terminalibus, paniculatis, multifloris, usque ad 35 cm longis, prophyllis magnis, haud cymbiformis, petalis usque ad medium connatis cum sepalis glabris tenuissime lineatis.

A scandent glabrous shrub, the branches stout, brown, reddish-brown, or sometimes nearly black when dry, prominently lenticellate. Leaves broadly ovate, thickly coraceous, entire, brownish-olivaceous when dry, somewhat shining, 10 to 20 cm long, 7 to 13 cm wide, the base very broadly rounded or truncate, apex obtuse to shortly and broadly blunt-acuminate; lateral nerves about 7 on each side of the midrib, prominent; petioles 3 to 6 cm long. Panicles terminal, very large, very many flowered, up to 35 cm long, the primary branches up to 20 cm in length. Flowers white, their pedicels 1 to 1.5 mm long, somewhat longer than the subtending bracteoles, the two prophylls subtending the flowers relatively large, ovate, acute or acuminate, 1.5 mm long. Sepals ovate, obtuse, about 0.7 mm long, very slightly lineate, margins entirely glabrous. Petals united to the middle, the lobes ovate, rounded, about 1 mm long, slenderly lineate.

LEYTE, Tigbao, near Tacloban, *Wenzel 1275, 1510* (type) May 29 and July 10, 1915, the latter indicated as growing in forests at sea level.

A very characteristic species in the alliance with *Maesa cumingii* Mez, well characterized by its unusually large, coriaceous, entire, broadly ovate leaves, and its very large many-flowered panicles.

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STUDIES ON PHILIPPINE RUBIACEAE, III [1]

By E. D. MERRILL [2]

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The present paper is essentially similar to the two preceding ones published under the same title and consists of the descriptions of apparently undescribed species in the genera *Neonauclea, Hedyotis, Urophyllum, Greeniopsis, Ophiorrhiza, Plectronia, Ixora, Grumilea,* and *Psychotria.* Twenty-three new species are proposed and described, and a new name is proposed for one previously described species of *Timonius.*

RUBIACEAE

NEONAUCLEA Merrill

NEONAUCLEA OLIGOPHLEBIA sp. nov.

Arbor circiter 8 m alta, capsulis exceptis glabra, ramis ramulisque teretibus, tenuibus; foliis in siccitate flavido-viridis, oblongis ad oblongo-obovatis, subcoriaceis, usque ad 9 cm longis, prominente obtuse acuminatis, basi angustatis, cuneatis, nervis utrinque 2 vel 3, adscendentibus, subtus prominentibus; capitulis terminalibus, solitariis vel trinis, longe pedunculatis, sub fructu circiter 8 mm diametro, capsulis anguste oblongo-obovoideis, circiter 2.5 mm longis, leviter hirsutis, apice 4-denticulatis.

A tree about 8 m high, glabrous except the somewhat hirsute capsules. Branches and branchlets slender, terete, cinereous in color. Leaves opposite, oblong to oblong-obovate, subcoriaceous, when dry yellowish-green, especially on the lower surface, somewhat shining, 5 to 9 cm long, 2.5 to 3.5 cm wide, the apex rather prominently subcaudate-acuminate, the acumen rather slender, blunt, usually about 1 cm long, the base gradually narrowed, cuneate; lateral nerves 2 or 3 on each side of the midrib, promi-

[1] Merrill, E. D., Studies on Philippine Rubiaceae, I, *Philip. Journ. Sci.* 8 (1913) *Bot.* 31–62, *t. 1;* Studies on Philippine Rubiaceae, II, *op. cit.* 10 (1915) *Bot.* 99–144.

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nent on the lower surface, ascending, curved-anastomosing, the reticulations distinct, slender, rather lax; petioles 5 to 8 mm long. Heads terminal, solitary or in threes, the slender peduncles about 3 cm long, the bract-scars at about the middle, the heads in fruit globose, dense, about 8 mm in diameter. Capsules crowded, somewhat angular, oblong-obovoid, about 2.5 mm long, the upper part hirsute, the persistent calyx-teeth 4, very short.

LEYTE, Tigbao, near Tacloban, *Wenzel 1608*, August 22, 1915, in forests at sea level.

A rather characteristic species in the group with *Neonauclea gracilis* (Vid.) Merr., and *N. philippinensis* (Vid.) Merr., but rather nearer the latter. It is distinguished by its yellowish-green, fewer-nerved leaves.

HEDYOTIS Linnaeus

HEDYOTIS LUZONIENSIS sp. nov.

Frutex circiter 1 m altus, ramosus, hispidus, ramulis quadrangulatis; foliis oblongo-ovatis ad elliptico-ovatis, usque ad 5 cm longis, obtusis, scabridis, subtus praesertim ad costa nervisque hispidis, nervis utrinque circiter 4; inflorescentiis axillaribus, solitariis, pedunculatis, 3 ad 6 cm longis; capsulis anguste obovoideis, hispidis, circiter 5 mm longis.

An erect branched shrub about 1 m high, parts distinctly hispid. Branches and branchlets dull-brownish, the latter distinctly 4-angled, slender. Leaves pale-greenish when dry, slightly shining, firmly chartaceous, oblong-ovate to elliptic-ovate, 2.5 to 5 cm long, 1.2 to 2.2 cm wide, subequally narrowed to the obtuse apex and to the acute base, scabrous, the lower surface hispid, especially on the midrib and lateral nerves; lateral nerves about 4 on each side of the midrib, not prominent, curved, anastomosing; petioles hispid, 2 to 4 mm long; stipules broad, hispid, abruptly contracted into a 3 mm long beak. Inflorescences axillary, solitary, peduncled, 3 to 6 cm long, 2.5 to 3 cm wide, hispid, the branches few, spreading, the primary bracts foliaceous, oblong, obtuse, narrowed below, 5 to 6 mm long, secondary ones spatulate, 2 to 3 mm long, the bracteoles linear, 1 to 1.5 mm long. Calyx immediately after anthesis about 3 mm long, the lobes 4, oblong-ovate, obtuse, 1 mm long. Capsules oblong-obovoid, 5 mm long, base acute, hispid, their pedicels 2 to 3 mm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26580 Ramos*, September 8, 1916, in forests, altitude at least 300 meters.

This species has much the aspect of *Hedyotis elmeri* Merr., but differs in its hispid indumentum and its smaller, fewer-nerved leaves. It is at once distinguished from *H. macgregorii* Merr. by its elongated inflorescences.

UROPHYLLUM Wallich

UROPHYLLUM LUZONIENSE sp. nov.

Frutex erectus, glaber; foliis coriaceis, oblongo-ellipticis ad oblongo-ovatis, usque ad 7 cm longis, olivaceis, nitidis, utrinque subaequaliter angustatis, basi acutis, apice acuminatis, nervis utrinque 7 vel 8, subtus prominentibus; fructibus axillaribus, solitariis, longe pedicellatis, urceolato-ovoideis, circiter 5 mm diametro.

An erect glabrous shrub about 2 m high, the branches rather stout, subterete, brownish, about 5 mm in diameter, the branchlets smooth, dark brown, somewhat shining. Leaves coriaceous, olivaceous when dry, shining, of about the same color on both surfaces, oblong-elliptic to oblong-ovate, 4 to 7 cm long, 2 to 3.5 cm wide, subequally narrowed to the acute base and to the somewhat acuminate apex; lateral nerves 7 or 8 on each side of the midrib, very prominent on the lower surface, curved, anastomosing, the reticulations prominent; petioles 1 to 1.5 cm long; stipules ovate, acute, deciduous, about 7 mm long. Fruits axillary, solitary, urceolate-ovoid and black when dry, about 5 mm in diameter, the persistent calyx-rim truncate, the pedicels 2 to 2.5 cm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26522 Ramos & Edaño*, September 8, 1916, in forests, altitude at least 300 meters.

The alliance of this species is with *Urophyllum bataanense* Elm., from which it is distinguished by its smaller, fewer-nerved leaves and its long-peduncled fruits.

UROPHYLLUM MICROPHYLLUM sp. nov.

Frutex, plus minusve ciliato-pilosus; foliis oblongo-ovatis, firmiter chartaceis vel subcoriaceis, usque ad 2.5 cm longis, acuminatis, basi acutis, nervis utrinque 5 vel 6, subtus prominentibus; fructibus axillaribus, solitariis breviter pedicellatis, ovoideis, circiter 2 mm diametro, pubescentibus, calycis lobis 4, late triangularis, circiter 1 mm longis.

An erect, much-branched shrub about 2 m high, the branchlets, petioles, margins of the leaves, and the midrib and lateral nerves on the lower surface prominently ciliate-pilose with soft, appressed or subappressed, pale hairs. Branches terete, grayish-brown, glabrous or nearly so. Leaves oblong-ovate, firmly chartaceous to subcoriaceous, 2 to 2.5 cm long, 0.8 to 2.3 cm wide, brownish-olivaceous or pale when dry, base acute, apex rather prominently acuminate, the upper surface glabrous or, when young, sparingly pilose on the midrib, the margins ciliate-pilose; lateral nerves 5 or 6 on each side of the midrib,

rather prominent on the lower surface, anastomosing, curved, the reticulations not prominent, the nerves and midrib ciliate-pilose on the lower surface; petioles densely ciliate-pilose, 2 to 4 mm long; stipules lanceolate, acuminate, pubescent, about 6 mm long. Fruits axillary, solitary, pubescent, ovoid or cup-shaped, about 4 mm in diameter, their pedicels pubescent, 1 to 2 mm long, the bracteoles oblong-lanceolate, pubescent, as long as the pedicels, the calyx-teeth 4, broadly triangular, somewhat acuminate, pubescent, about 1 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26389 Ramos & Edaño*, August 20, 1916, in forests near the summit of the mountain, altitude about 1,000 meters.

A very characteristic species not closely allied to any other form known to me. It is readily recognized by its indumentum; its small leaves; and its solitary, short-pedicelled, pubescent fruits.

UROPHYLLUM SUBGLABRUM sp. nov.

Frutex vel arbor parva, partibus junioribus parcissime ciliato-pilosus glabrescentibus; foliis chartaceis, anguste oblongis, usque ad 15 cm longis, prominente acuminatis, basi acutis, nervis utrinque circiter 9, stipulis oblongo-ovatis, circiter 6 mm longis; inflorescentiis axillaribus, solitariis, pedunculatis, depauperato umbellatis, fructibus ovoideis, circiter 6 mm longis, longe pedicellatis, parcissime adpresse ciliatis.

A shrub or small tree, the stipules, petioles, and leaves with few, widely scattered, long, white, ciliate hairs, in age glabrous or nearly so. Branches pale-brownish, terete, glabrous, the branchlets obscurely rounded-angled or somewhat compressed, the internodes 2 to 3 cm long. Leaves pale-olivaceous when dry, slightly shining, narrowly oblong, chartaceous, 9 to 15 cm long, 3 to 4 cm wide, narrowed below to the acute base, and above to the rather prominently acuminate apex, the acumen slender, blunt; lateral nerves about 9 on each side of the midrib, slender, curved, anastomosing; petioles 1 to 1.5 cm long; stipules oblong-ovate, subacute, about 6 mm long; infructescences axillary, solitary, depauperate umbellate, each bearing from 1 to 3 fruits, the peduncles 1 to 1.5 cm long, the pedicels as long as the peduncles. Fruits yellow when fresh, fleshy, when dry dark brown, ovoid, about 6 mm in diameter, sparingly appressed-ciliate with scattered, long, white hairs, the calyx-teeth more pubescent than the tube, acute, short.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26507 Ramos & Edaño*, September 6, 1916, on dry slopes, altitude about 100 meters, known to the Balugos as *tarambuyen*.

In many respects this species resembles *Urophyllum arboreum* (Blume) Korth. (*U. glabrum* Wall.), from which it is readily distinguished by its very sparse indumentum; its few-flowered umbels; and its much shorter stipules.

GREENIOPSIS Merrill

GREENIOPSIS DISCOLOR sp. nov.

Arbor circiter 5 m alta, foliis subtus densissime minuteque albido-lanosis et paniculis brunneo-pubescentibus exceptis glabra; foliis confertis, coriaceis, anguste oblongo-obovatis, supra brunneis, nitidis, subtus albidis vel griseis, usque ad 12 cm longis, acuminatis, basi angustatis, acutis, nervis utrique 15 ad 18, subtus valde prominentibus, adscendentibus; paniculis terminalibus, pedunculatis, usque ad 15 cm longis, multifloris, brunneo-pubescentibus; fructibus subellipsoideis, circiter 5 mm longis.

A tree about 5 m high, the panicles brown-pubescent, the lower surface of the leaves densely and minutely white-lanate, otherwise glabrous. Branches terete, brownish. Leaves crowded toward the apices of the branchlets, coriaceous, narrowly oblong-obovate, 8 to 12 cm long, 3 to 5 cm wide, acuminate, gradually narrowed below to the cuneate base, the upper surface dark brown and shining when dry, the lower white or grayish; lateral nerves 15 to 18 on each side of the midrib, prominent beneath; petioles brown, 1 to 2 cm long; stipules lanceolate, acuminate, dark brown, glabrous, 12 to 15 mm long. Panicles terminal, peduncled, up to 15 cm long, the peduncles 4 cm long or less, the branches opposite, the lower ones up to 6 cm long, brown-pubescent, many flowered, the flowers scorpoidly arranged on the ultimate branchlets. Flowers yellowish-white, 5-merous, their pedicels 1 to 3 mm long. Calyx urceolate, pubescent, about 2 mm long, the lobes reniform-ovate, truncate-rounded, less than 1 mm long. Corolla 4 mm long, somewhat funnel-shaped, pubescent, the lobes 5, reniform, about 1 mm long and 2 mm wide. Style slender, 3 mm long; stigma capitate. Anthers oblong, 1.2 mm long. Capsule subellipsoid, brown when dry, pubescent, about 5 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26448 Ramos & Edaño*, August 15, 1916, on forested slopes, altitude about 300 meters, known to the Balugos as *pangalimanan*.

A most characteristic species, at once distinguished from all other known forms of the genus by its small leaves, which are dark brown, glabrous, and shining on the upper surface, and densely but minutely white-lanate on the lower surface. The midribs and lateral nerves on the lower surface are dark brown in striking contrast to the pale dense indumentum.

GREENIOPSIS MEGALANTHA sp. nov.

Arbor circiter 10 m alta, partibus junioribus inflorescentiisque exceptis glabra; foliis coriaceis, oblongo-ovatis ad oblongo-lanceolatis, nitidis, brunneo-olivaceis, usque ad 25 cm longis, tenuiter acuminatis, basi acutis, nervis utrinque 11 ad 13, prominentibus; inflorescentiis longe pedunculatis, dense adpresse pubescentibus; floribus numerosis, circiter 1.5 cm longis.

A tree about 10 m high, glabrous except the inflorescences and the younger parts. Branches glabrous, smooth, terete or somewhat compressed, the branchlets compressed, usually dark, appressed cinereous-pubescent. Leaves coriaceous, oblong-ovate to oblong-lanceolate, brownish-olivaceous, shining, and of about the same color on both surfaces when dry, glabrous, narrowed upward to the slenderly acuminate apex, the base acute; lateral nerves 11 to 13 on each side of the midrib, prominent, curved, the reticulations very slender; petioles about 2.5 cm long, nearly black when dry, glabrous; stipules lanceolate, slenderly acuminate, brownish when dry, ultimately glabrous, about 2 cm long. Panicles terminal, all parts densely appressed-pubescent with pale-brownish or cinereous hairs, usually trichotomously branched, the peduncles about 14 cm long, about equalling the flower-bearing portions. Flowers numerous, white, cymosely arranged, about 1.5 cm long, somewhat funnel-shaped. Calyx somewhat campanulate, densely pubescent, about 7 mm long, the lobes subreniform, 2 mm long and 3 mm wide. Corolla densely pubescent externally, the lower 3 mm of the tube cylindric, then enlarged, inside densely bearded below the insertion of the stamens, the lobes somewhat recurved, reniform, 3 mm long, 5 mm wide. Anthers 2 mm long. Style glabrous, 8 mm long. Stigma much thickened, somewhat cleft, about 2 mm long.

MINDANAO, Surigao Province, Cayungan, Adlay Barrio, *For. Bur. 26004 Mallonga*, June 22, 1916, along streams, altitude about 15 meters.

A most characteristic species, at once distinguished among all known forms of this genus by its large flowers.

OPHIORRHIZA Linnaeus

OPHIORRHIZA OBLONGILIMBA sp. nov.

Fructicosus, erectus, ramosus, usque ad 25 cm altus, ramulis junioribus subtus foliis ad costa nervisque et inflorescentiis puberulis vel brevissime pubescentibus; foliis oblongis ad oblongo-lanceolatis, usque ad 6.5 cm longis et 1 cm latis, olivaceis, subtus pallidioribus, integris, nervis utrinque 6 ad 8; stipulis 2 ad 3 mm longis, longe acuminatis; cymis terminalibus, solitariis, pe-

dunculatis, paucifloris; floribus circiter 4 mm longis; fructibus subtruncatis, glabris, 2.5 ad 3 mm longis, 5 ad 6 mm latis.

An erect, somewhat branched undershrub, 10 to 25 cm high, the stems glabrous, woody, brownish-gray, terete, about 3 mm in diameter, branched at or from above the base. Branchlets appressed brownish-puberulent with short, dirty-brown hairs. Leaves membranaceous, oblong to oblong-lanceolate, 3 to 6.6 cm long, 6 to 10 mm wide, apex acute to subobtuse, base narrowed, acute, entire, the upper surface dark olivaceous, somewhat shining, glabrous or nearly so, the lower surface paler, puberulent or short-pubescent on the midrib and lateral nerves; nerves 6 to 8 on each side of the midrib, slender, curved, not prominent; petioles slender, 5 to 10 mm long; stipules 2 to 3 mm long, long and slenderly acuminate from an ovate base. Cymes terminal, solitary, few-flowered, slightly branched, puberulent, each with from about 5 to 9 flowers. Flowers 5-merous, about 4 mm long. Calyx-tube globose, minutely puberulent, 1.5 mm long, the minute teeth ovate, acute, 0.2 mm long. Fruit glabrous, compressed, subtruncate, 2.5 to 3 mm long, 5 to 6 mm wide. Seeds numerous, about 0.3 mm in diameter.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27139* (type) *27335 Ramos*, March, 1917, in forests along streams at low altitudes.

This species is characterized by its erect, woody stems; its oblong to oblong-lanceolate leaves, which do not exceed 1 cm in width; and its small, few-flowered, slenderly pedicelled cymes. It conforms closely with the description of *Ophiorrhiza oblongifolia* DC., the type of which was from Luzon, but is entirely different from de Candolle's species as currently interpreted, while the leaves are not velutinous beneath.

TIMONIUS de Candolle

TIMONIUS SAMARENSIS nom. nov.

Timonius macrophyllus Merr. in Philip. Journ. Sci. 5 (1910) Bot. 246, non Valeton, 1909.

This new name is necessarily for the Samar plant I described as *Timonius macrophyllus*, as Valeton[3] published the same combination for the species he considered under the name *Timonius amboinensis* (Miq.) Boerl., in a note following his description. *Timonius macrophyllus* Valeton was based on *Greenia macrophylla* Teysm. & Binn., this name antedating *Polyphragmon amboinicum* Miq. by one year. *Timonius macrophyllus* Valeton was overlooked by the compilers of the fourth supplement to Index Kewensis.

PLECTRONIA Linnaeus

PLECTRONIA ELLIPTICA sp. nov.

Frutex circiter 1 m altus, petiolis inflorescentiis et subtus foliis

[3] Bull. Dépt. Agr. Ind. Néerl. 26 (1909) 45.

parce ciliato-setosus; foliis ellipticis, subcoriaceis, usque ad 12 cm longis, in siccitate brunneis vel olivaceo-brunneis, utrinque aequaliter angustatis, basi acutis, apice acutis ad obscure obtuseque acuminatis, nervis utrinque 5 ad 6, distinctis; inflorescentiis axillaribus, solitariis, umbellatis, breviter, pedunculatis, 6- ad 8-floris, bracteis binis 7 ad 8 mm longis valde acuminatis instructis.

An erect shrub about 1 m high, according to the collector. Branches terete, smooth, brownish or yellowish-brown, glabrous, the branchlets brown, slender, shining. Leaves subcoriaceous or firmly chartaceous, elliptic to oblong-elliptic, 7 to 12 cm long, 4 to 5.5 cm wide, brownish or brownish-olivaceous when dry, of the same color on both surfaces, shining, the apex acute to shortly blunt-acuminate, base acute, the upper surface glabrous, the lower ciliate-setose with scattered pale hairs especially on the midrib and nerves; lateral nerves 5 or 6 on each side of the midrib, distinct, scarcely anastomosing, the secondary ones and reticulations obsolete; petioles sparingly ciliate-setose, 2 to 5 mm long; stipules prominently acuminate from a somewhat broadened base, 6 to 7 mm long. Umbels axillary, solitary, 6- to 8-flowered, their peduncles about 2 mm long, each umbel subtended by two conspicuous bracts 7 to 8 mm in length, these prominently acuminate from the 3 to 4 mm long base, obscurely keeled; bracteoles numerous, ovate, 2 mm long or less. Pedicels 2 to 4 mm long, sparingly ciliate-setose. Calyx short, about 2 mm in diameter, the teeth ovate, acute, 0.5 mm long or less.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26327 Ramos & Edaño*, August 21, 1916, from the summit of the mountain, altitude not indicated.

A species well characterized by the two, conspicuous, prominently acuminate bracts subtending the few-flowered, short-peduncled umbels; and the scattered ciliate-setose indumentum.

PLECTRONIA CORDATA sp. nov.

Frutex, foliis floribusque in siccitate nigris, ramulis junioribus subtus foliis inflorescentiisque dense pubescentibus; foliis chartaceis vel subcoriaceis, oblongis ad oblongo-ovatis, usque ad 12 cm longis, brevissime petiolatis, apice acutis, basi late rotundatis cordatisque, nervis utrinque circiter 5; floribus numerosis, axillaribus, fasciculatis, 5-meris, breviter pedicellatis, calycibus pubescentibus, circiter 1 mm longis.

A shrub about 1 m high, according to the collector; the vegetative parts rather uniformly black when dry. Branches and branchlets terete, the former glabrous, brownish, the latter rather densely pubescent with short, pale or dark hairs. Leaves

firmly chartaceous or subcoriaceous, oblong to oblong-ovate, 7 to 12 cm long, 3.5 to 5.5 cm wide, apex acute, base broadly rounded and distinctly cordate, the upper surface glabrous, shining, the lower densely and rather softly pubescent, the indumentum blackish; lateral nerves about 5 on each side of the midrib, rather prominent, laxly anastomosing; petioles 2 to 4 mm long; stipules truncate, about 1 mm long. Flowers white, axillary, subfasciculate, rather numerous, black when dry, their pedicels slender, pubescent, 2 to 3 mm long, the bracteoles ovate, pubescent, acute, 0.5 mm long. Calyx about 1 mm long, pubescent, the teeth 5, broadly ovate, acute, 0.5 mm long. Petals, in bud, 1 mm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26549 Ramos & Edaño*, August 25, 1916, on dry slopes, altitude about 200 meters.

A species well characterized by its vegetative and floral parts being uniformly black or blackish when dry; its short-petioled, cordate leaves; and its indumentum. It is not closely allied to any other species known to me.

PLECTRONIA OBOVATIFOLIA sp. nov.

Frutex erectus, glaber, ramulis plus minusve quadrangulatis; foliis obovatis, crasse coriaceis, usque ad 7 cm longis, apice rotundatis, basi angustatis, acutis vel decurrento-acuminatis, nervis utrinque 3 vel 4, subtus valde prominentibus et in axillis glandulis magnis instructis; inflorescentiis axillaribus, umbellatis, breviter pedunculatis, circiter 6-floris.

An erect shrub or small tree, entirely glabrous, the branches and branchlets more or less quadrangular, brownish, the internodes 1 to 2 cm long. Leaves thickly coriaceous, obovate, 4.5 to 7 cm long, 2.5 to 4 cm wide, very dark olivaceous to somewhat brownish when dry, shining, apex rounded, base narrowed, acute or decurrent-acuminate; lateral nerves 3 or 4 on each side of the midrib, very prominent and supplied with large axillary glands on the lower surface, somewhat ascending, curved, evanescent or very obscurely anastomosing, the secondary nerves and reticulations mostly obsolete; petioles 3 to 8 mm long; stipules coriaceous, broadly ovate, rather abruptly and prominently acuminate, 5 to 6 mm long. Umbels about 6-flowered, axillary, solitary, their peduncles rather stout, black when dry, 3 to 5 mm long. Bracts subtending the flowers ovate, acute, about 4 mm long. Pedicels 3 to 4 mm long. Calyx about 2 mm in diameter, shallow, obscurely toothed, the teeth subacute or acuminate. Petals in bud about 3 mm long.

LUZON, Tayabas Province, Mount Dalindingan, *Bur. Sci. 26526 Ramos*

& Edaño, September 9, 1916, on forested slopes at medium altitudes, locally known to the Balugos as *taratapak.*

The alliance of this species is manifestly with *Plectronia gynochthodes* Baill. (*P. umbellata* K. Sch.), from which it is readily distinguished by its differently shaped, very coriaceous leaves and by the prominent glands in the axils on the lower surface.

PLECTRONIA SUBSESSILIFOLIA sp. nov.

Frutex circiter 2 m altus, glaber, ramis teretibus, ramulis plus minusve compressis; foliis coriaceis vel subcoriaceis, brevissime petiolatis, ellipticis ad obovato-ellipticis, usque ad 9 cm longis, basi acutis, apice obtusis ad latissime et obscure acuminatis, in siccitate olivaceis vel brunneo-olivaceis, nitidis, nervis utrinque 5 vel 6, subtus prominentibus, in axillis prominente glandulosis; fructibus axillaribus, pedicellatis, solitariis vel subsolitariis, obconicis, truncatis, circiter 7 mm longis, prominente longitudinaliter 8-carinatis.

A glabrous erect shrub about 2 m high, the branches terete, grayish, the branchlets more or less compressed, sometimes sulcate, brownish-olivaceous, smooth. Leaves coriaceous or subcoriaceous, elliptic to obovate-elliptic, brownish-olivaceous and shining when dry, 7 to 9 cm long, 3.5 to 4.5 cm wide, base acute, apex obtuse to very broadly and obtusely acuminate; lateral nerves 5 or 6 on each side of the midrib, prominent on the lower surface, somewhat ascending, slightly curved, scarcely anastomosing, prominently glandular in the axils, the secondary nerves and reticulations obsolete; petioles 2 mm long or less; stipules ovate-lanceolate, acuminate, 4 mm long. Fruits axillary, solitary or rarely two on a very short peduncle, yellow when mature, dark brown when dry, obconic, truncate, about 7 mm long, with eight prominent longitudinal keels especially prominent at the tip of the fruit, narrowed below, the pedicels about 5 mm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27205 Ramos & Edaño,* March 2, 1917, in thickets at low altitudes.

In appearance this species approximates *Plectronia obovatifolia* Merr., but is easily distinguished by its more numerous lateral nerves. The turbinate, truncate, prominently keeled fruits are most characteristic, the keels being evident in the very youngest fruits.

IXORA Linnaeus

IXORA ILOCANA sp. nov.

Frutex parvus, erectus, glaber, ramis ramulisque teretibus; foliis oblongis, chartaceis, breviter petiolatis, usque ad 6 cm longis, acutis vel minute acuminatis, basi acutis, nervis utrinque circiter 12, tenuibus, anastomosantibus; stipulis circiter 3 mm longis, e basi ovatis longe tenuiter caudato-acuminatis; infruc-

tescentiis terminalibus, circiter 2 cm longis, sessilibus vel breviter pedunculatis, simplicibus vel dichotomis, fructibus 1 ad 4, globosis, circiter 6 mm diametro, tenuiter pedicellatis.

An erect glabrous shrub said by the collector to be about 1 m high, the branches and branchlets slender, terete, grayish to brown, the latter about 1 mm in diameter. Leaves oblong, chartaceous, rather pale when dry, of about the same color on both surfaces, somewhat shining, 4 to 6 cm long, 1 to 2 cm wide, slightly and subequally narrowed to the acute or minutely acuminate apex and the acute base; lateral nerves about 12 on each side of the midrib, slender, anastomosing, slightly more prominent than are the secondary ones and the lax reticulations; petioles 2 mm long; stipules about 3 mm long, prominently caudate-acuminate from an ovate base. On some branches supplementary pairs of greatly reduced, linear-oblong, 5 to 10 mm long leaves are borne immediately above the normal ones. Infructescences terminal, sessile or shortly peduncled, simple or once forked, the primary branches simple or once forked, the whole infructescence 2 cm long or less. Fruits 1 to 4, globose, reddish-yellow when fresh, brown when dry, smooth, shining, about 6 mm in diameter, the pedicels 5 to 7 mm long, the bracts and bracteoles linear-lanceolate, acuminate, 2 to 3 mm long.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27325 Ramos*, March 11, 1917, in forests along streams at low altitudes.

This species is apparently most closely allied to *Ixora gracilipes* Merr., and is characterized by its unusually small leaves and depauperate, slender infructescences. It differs from *Ixora gracilipes* notably in its thinner leaves; caudate-acuminate, not truncate stipules; and much shorter infructescences.

GRUMILEA Gaertner

GRUMILEA LAGUNENSIS sp. nov.

Frutex erectus, partibus junioribus subtus foliis ad costa nervisque et inflorescentiis fusco-pubescentibus; foliis chartaceis, oblongo-ovatis, usque ad 20 cm longis, acuminatis, basi acutis, nervis utrinque circiter 17, subadscendentibus, subtus prominentibus; infructescentiis brevibus, fructibus paucis, oblongo-obovoideis, in siccitate brunneis, glabris, 1 cm longis, prominente longitudinaliter sulcatis, albumine valde ruminato.

An erect shrub, more or less brown-pubescent. Branches terete, grayish-brown, smooth, glabrous, the younger branchlets rather densely brown-pubescent. Leaves chartaceous, oblong-ovate, about 20 cm long, 9 to 10 cm wide, narrowed upward to the acuminate apex, base acute, olivaceous when dry, the upper surface glabrous, slightly shining, the lower prominently brown-

pubescent on the midrib and lateral nerves; lateral nerves about 17 on each side of the midrib, very prominent on the lower surface, subascending, anastomosing; petioles pubescent, 1.5 to 2 cm long. Panicles in fruit brown-pubescent, 2 to 3 cm long. Fruits few, yellow when fresh, when dry dark brown, glabrous, oblong-obovoid, 1 cm long, prominently sulcate longitudinally with usually eight distinct keels. Albumen prominently ruminate throughout.

LUZON, Laguna Province, San Antonio, *Bur. Sci. 23826 Ramos*, October 19, 1915, in damp forests.

This species in vegetative characters somewhat resembles *Grumilea velutina* Elm., from which it is distinguished at once by its brown, not pale indumentum, and more numerously nerved leaves.

GRUMILEA PROPINQUA sp. nov.

Frutex erectus, partibus junioribus subtus foliis ad costa nervisque et inflorescentiis rubiginoso-pubescentibus; foliis oblongo-obovatiis ad oblongo-ellipticis, usque ad 14 cm longis, in siccitate cupreis, acutis vel obscure acute acuminatis, deorsum angustatis, basi cuneatis, nervis utrinque 8 ad 10. Inflorescentiis terminalibus, brevissime pedunculatis vel e basi ramosis, circiter 4 cm longis; floribus in ramulis ultimis subcapitato-dispositis, 6 ad 7 mm longis; fructibus junioribus rubiginoso-pubescentibus.

An erect shrub, about 1 m high according to the collector, prominently rubiginous-pubescent, all parts cupreous when dry. Branches terete, glabrous, brown, the branchlets rather densely pubescent. Leaves firmly chartaceous to subcoriaceous, oblong-obovate to oblong-elliptic, 9 to 14 cm long, 3.5 to 5.5 cm wide, apex acute or shortly acute acuminate, usually narrowed below, base cuneate, the upper surface glabrous, shining, the lower minutely scaberulous from the short scattered hairs on the surface, the midrib and nerves rather densely pubescent; petiole pubescent, 5 to 8 mm long; stipules triangular-ovate, acuminate, pubescent, about 6 mm long. Panicles terminal, about 4 cm long, shortly peduncled or branched from the base, rubiginous-pubescent, the branches few, the flowers subsessile and densely crowded at the tips of the branchlets. Flowers white, 6 to 7 mm long. Calyx about 3 mm long, pubescent, cuneate, the teeth ovate, acute, ciliate, 1 mm long. Corolla pubescent externally, the tube about 2 mm long, lobes as long as the tube, oblong, obtuse. Young fruits subellipsoid, about 7 mm long, not sulcate, more or less rubiginous-pubescent.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26570 Ramos & Edaño*, August 27, 1916 (type): Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26343 Ramos & Edaño*, August 6, 1916, in forests.

The alliance of this species is manifestly with *Grumilea rubiginosa* (Elm.) Merr., from which it is distinguished by its smaller, fewer-nerved leaves and its much shorter inflorescences. In *Grumilea rubiginosa* the panicles are long-peduncled, while in the present species they are usually branched from the base.

GRUMILEA FUSCA sp. nov.

Frutex erectus, circiter 1 m altus, ramulis petiolis foliis ad costa nervisque et inflorescentiis prominente fusco-pubescentibus; foliis in siccitate brunneis, oblongo-ellipticis, usque ad 18 cm longis, utrinque subaequaliter angustatis, apice acutis ad leviter obtusis, basi acutis, nervis utrinque 13 ad 15, subtus valde prominentibus; inflorescentiis confertis, rubiginoso-pubescentibus, calycis dentibus lanceolatis, acuminatis; fructibus obovoideis, glabris, in siccitate leviter rugosis; seminibus 1 vel 2, albumine valde ruminato.

An erect, simple or sparingly branched shrub 0.7 to 1 m high, the stems terete, brown, glabrous, about 8 mm in diameter, the young branchlets densely brownish-rubiginous-pubescent, the hairs somewhat crisped, spreading. Leaves oblong-elliptic, brown when dry, shining, chartaceous, 12 to 18 cm long, 5 to 8 cm wide, subequally narrowed to the acute or somewhat obtuse apex and to the acute base, the upper surface entirely glabrous, the lower prominently brown-pubescent on the midrib and lateral nerves; the latter 13 to 15 on each side of the midrib, very prominent on the lower surface, curved, obscurely anastomosing close to the margin, the reticulations prominent; petioles densely pubescent, 2 to 3 cm long; stipules densely pubescent, ovate to ovate-lanceolate, apiculate-acuminate. Young inflorescence dense, sessile, subcapitate, the flowers crowded. Calyx rubiginous-pubescent, subsessile, the tube short, the lobes lanceolate, acuminate, 1 to 1.2 mm long. Corolla-lobes oblong-ovate, acuminate, 3 mm long. Panicle in fruit 4 cm long, branched from the base, densely pubescent, the indumentum brown rubiginous. Fruits dark red when fresh, dark brown when dry, obovoid, about 8 mm long, not at all longitudinally ridged or sulcate but somewhat rugose when dry, 1- or 2-seeded, when 1-seeded slightly inequilateral, the seeds plano-convex, very prominently ruminate throughout.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26232 Ramos & Edaño*, August 14, 1916 (type): Tayabas Province, Mount Dingalan, *Bur. Sci. 26600 Ramos & Edaño*, August 25, 1916, altitude 200 to 300 meters.

This species is well characterized by its oblong-elliptic leaves, which are brown when dry, its characteristic indumentum, and its prominently

ruminate seeds. It does not appear to be closely related to the other known Philippine representatives of the genus.

GRUMILEA YATESII sp. nov.

Frutex glaber, erectus, 1 ad 2 m altus; foliis oblongo-ellipticis ad obovato-ellipticis, usque ad 20 cm longis, in siccitate subolivaceis, nitidis, apice breviter obtuse acuminatis, basi acutis, nervis utrinque circiter 15, subtus valde prominentibus; infructescentiis terminalibus, brevibus, breviter pedunculatis vel e basi ramosis, 2 ad 4 cm longis; fructibus subglobosis, circiter 8 mm diametro, in siccitate nigris, haud sulcatis; seminibus plano-convexis, albumine plus minusve ruminato.

An erect glabrous shrub 1 to 2 m high, the branches terete, brownish or dark reddish brown, 5 to 7 mm in diameter. Leaves firmly chartaceous, oblong-elliptic to obovate, elliptic, 12 to 20 cm long, 6 to 10 cm wide, the upper surface usually olivaceous, shining, the lower paler, apex abruptly and shortly blunt-acuminate, base acute; lateral nerves about 15 on each side of the midrib, very prominent on the lower surface, somewhat curved, obscurely anastomosing close to the somewhat revolute margins, the reticulations distinct; petioles 1 to 1.5 cm long; stipules deciduous. Infructescences terminal, 2 to 4 cm long, branched from the base or shortly peduncled, the branches spreading, short. Fruits subglobose, dark red to nearly black when mature, the pericarp somewhat fleshy, when dry nearly black, smooth, about 8 mm in diameter. Seeds plano-convex, the albumen somewhat ruminate.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25518* (type), *25417*, *Yates*, December 11 and 16, 1916, in forests at low altitudes.

This species somewhat resembles *Psychotria plumierifolia* Elm., but is distinguished in many characters, notably in its very much shorter infructescences, which in Elmer's species are about one-half as long as the leaves.

GRUMILEA BRACHYBOTRYS sp. nov.

Frutex vel arbor parva, glabra; foliis firmiter chartaceis vel subcoriaceis, oblongis, usque ad 10 cm longis, in siccitate pallide olivaceis, utrinque concoloribus, basi acutis, apice breviter obtuse acuminatis, nervis utrinque circiter 12; infructescentiis terminalibus, pedunculatis, circiter 2 cm longis; fructibus paucis, obovoideis, 1 ad 1.2 cm longis, in siccitate brunneis, obscure sulcatis; seminibus valde bicarinatis, albumine ruminato.

A shrub or a small tree, entirely glabrous. Branches terete, brownish, the branchlets somewhat compressed. Leaves oblong, firmly chartaceous or subcoriaceous, pale olivaceous, somewhat shining, and of the same color on both surfaces when dry, base

acute, apex somewhat blunt-acuminate, 7 to 10 cm long, 2 to 3.5 cm wide, subequally narrowed at both ends; lateral nerves about 12 on each side of the midrib, distinct, anastomosing; petioles 8 to 12 mm long. Infructescences terminal, about 2 cm long, one or two terminating each branchlet, simple, each bearing one or two sessile fruits. Fruits obovoid, 10 to 12 mm long, dark brown when dry, obscurely sulcate. Seeds very prominently bicarinate, the keels thin, about 2 mm high. Albumen ruminate.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26256 Ramos & Edaño*, August, 1916.

In vegetative characters this species somewhat resembles *Grumilea subalpina* (Elm.) Merr., but its leaves are smaller. It differs notably from this species in its fewer and very much larger fruits and in its very prominent bicarinate seeds.

GRUMILEA ILOCANA sp. nov.

Frutex glaber, erectus; foliis oblongo-obovatis ad obovatis, subcoriaceis, usque ad 9 cm longis, obtusis ad late obtuseque acuminatis, basi cuneatis, nitidis, in siccitate pallide brunneis, nervis utrinque circiter 9, tenuibus, distinctis; stipulis oblongo-ovatis, obtusis, circiter 3 mm longis, caducis; infructescentiis 2.5 ad 5 cm longis, pedunculatis vel e basi ramosis; fructibus paucis, obovoideis, teretibus, in siccitate brunneis, circiter 7 mm longis; seminibus plano-convexis, laevis, albumine valde ruminato.

An erect glabrous shrub, the branches terete, brownish or grayish-brown, somewhat wrinkled, the branchlets compressed, brownish, smooth. Leaves subcoriaceous, smooth, oblong-obovate to obovate, 5 to 9 cm long, 2.5 to 4 cm wide, shining, brownish or pale brownish and of about the same color on both surfaces when dry, apex obtuse to shortly and broadly obtuse-acuminate, narrowed below to the cuneate base; lateral nerves about 9 on each side of the midrib, slender, distinct, obscurely anastomosing, the reticulations very lax, nearly obsolete; petioles 5 to 10 mm long; stipules caducous, oblong-ovate, obtuse, about 3 mm long. Panicles in fruit 2.5 to 5 cm long, peduncled or branched from the base. Fruits obovoid, about 7 mm long, smooth, terete, longitudinally and faintly ribbed, brown when dry. Seeds plano-convex, smooth, the albumen prominently and uniformly ruminate throughout.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27456* (type), *27459*, *27544 Ramos*, February, 1917, in thickets and forests at low altitudes.

The alliance of this species is manifestly with *Grumilea luconiensis* (Cham.) F.-Vill., from which it is readily distinguished by its differently shaped, fewer-nerved leaves.

PSYCHOTRIA Linnaeus

PSYCHOTRIA DEPAUPERATA sp. nov.

Frutex erectus, circiter 0.5 m altus, ramosus, partibus junioribus et subtus foliis ad costa ferrugineo-pubescentibus; foliis anguste oblongis ad oblongo-lanceolatis, usque ad 7 cm longis, utrinque subaequaliter angustatis, acutis vel obscure acuminatis, nervis tenuibus, utrinque circiter 10; fructibus in axillis superioribus, solitariis, obovoideis, obscure sulcatis, glabris, circiter 6 cm longis; seminibus concavo-convexis, albumine aequabile.

An erect, much-branched undershrub about 0.5 m high, the branchlets, petioles, and midribs on the lower surface of the leaves ferruginous-pubescent. Branches terete, grayish or brownish. Leaves firmly chartaceous, narrowly oblong to oblong-lanceolate, 3 to 7 cm long, 10 to 17 mm wide, subequally narrowed to the acute base and apex, or the apex slightly acuminate, subolivaceous when dry, the upper surface glabrous, shining, the lower much paler, ferruginous-pubescent on the midrib, otherwise glabrous; lateral nerves about 10 on each side of the midrib, slender; petioles ferruginous-pubescent, about 5 mm long. Fruits in the uppermost axils, solitary, glabrous, yellow when fresh, brown when dry, narrowly obovoid, about 6 mm long, apex rounded, base cuneate, obscurely sulcate when dry; seeds concavo-convex, the back with 3 or 4 shallow longitudinal ridges, the albumen not at all ruminate; pedicels about 6 mm long, recurved, sparingly pubescent.

ALABAT, back of Sangirin, *Merrill 10487*, December 23, 1916, on dry ridges in virgin forest, altitude about 100 meters; of very local occurrence.

The alliance of this species is manifestly with *Psychotria linearis* Bartl. (*Amaracarpus longifolius* Elm.), from which it is at once distinguished by its entirely differently shaped leaves.

PSYCHOTRIA SAMARENSIS sp. nov.

Arbor circiter 5 m alta, ramulis subtus foliis et inflorescentiis prominente ferrugineo-pubescentibus; foliis oblongis, firmiter chartaceis, usque ad 15 cm longis, utrinque subaequaliter angustatis, apice acuminatis, basi acutis, supra in siccitate castaneis, subtus pallidioribus, nervis utrinque 10 ad 12; infructescentiis 5 ad 7 cm longis, breviter pedunculatis vel e basi ramosis; fructibus sessilibus, anguste obovoideis, haud sulcatis, leviter pubescentibus; seminibus plano-convexis.

A tree about 5 m high, the branchlets, lower surface of the leaves, petioles, and inflorescences prominently ferruginous-pubescent. Branches terete, slender, glabrous, smooth, pale-brownish when dry. Leaves firmly chartaceous, oblong, 11 to

15 cm long, 3 to 4 cm wide, castaneous when dry, subequally narrowed to the acuminate apex and the acute base, the upper surface shining, glabrous, the lower paler, with short, rather scattered hairs over the entire surface; lateral nerves 10 to 12 on each side of the midrib, rather prominent on the lower surface; petioles pubescent, 1.5 to 2 cm long; stipules deciduous. Panicles densely ferruginous-pubescent, in fruit 5 to 7 cm long, shortly peduncled or branched from the base, the branches 3 to 5, opposite, spreading, the fruits sessile at the apices of the primary branches, two or more fruits on each branch. Fruits red when fresh, when dry dark brown, narrowly obovoid, about 8 mm long, not at all sulcate, the upper part more or less ferruginous-pubescent. Seeds plano-convex, the albumen not at all ruminate.

SAMAR, Salcedo, *For. Bur. 23576 Lasquety*, March 11, 1915, on ridges, altitude about 200 meters.

This species is characterized by its brown indumentum, its oblong leaves, and its narrowly obovoid fruits, which are sessile and somewhat fascicled at the tips of the primary branches of the infructescences. It does not appear to be closely allied to any other described Philippine form.

PSYCHOTRIA CADIGENSIS sp. nov.

Frutex scandens, glaber, ramis ramulisque teretibus, griseis vel brunneis; foliis chartaceis, oblongis vel oblongo-ovatis, usque ad 10 cm longis, prominente tenuiter acuminatis, basi acutis, supra olivaceis, subtus pallidis, nitidis, nervis utrinque 8 vel 9, prominentibus; paniculis axillaribus terminalibusque, laxis, diffusis, pedunculatis, usque ad 10 cm longis; fructibus oblongo-ellipsoideis, circiter 5 mm longis, obscure longitudinaliter sulcatis.

A scandent, entirely glabrous shrub, the branches and branchlets terete, brown or grayish, smooth, the internodes 3 to 8 cm long. Leaves chartaceous, oblong to oblong-ovate, 7 to 10 cm long, 2.5 to 4 cm wide, the apex prominently and slenderly acuminate, the base acute, the upper surface olivaceous, the lower much paler, shining; lateral nerves 8 or 9 on each side of the midrib, prominent on the lower surface, here brownish in contrast with the pale epidermis, curved, anastomosing, the reticulations nearly obsolete; petioles 5 to 7 mm long; stipules deciduous. Panicles up to 10 cm long, peduncled, lax, diffuse, the branches few, opposite, up to 4 cm in length. Fruit white when fresh, oblong-ellipsoid, about 5 mm long, brownish when dry and obscurely longitudinally sulcate.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25484* (type), *25533 Yates*, December, 1916, in forests, altitude 350 to 500 meters.

This species resembles *Psychotria diffusa* Merr., to which it is certainly

well summarized by Worcester.[3] These include references to a number of eruptions previous to 1707. Some of the eruptions

FIG. 1. Lake Bombon and Volcano Island. (Depths and elevations are given in meters.)

have been very violent and have done much damage. The most severe and long continued on record occurred in 1754. The last eruption previous to 1911 was a small one in 1904. This did

[3] Worcester, Dean C., Taal Volcano and its recent destructive eruption, *National Geographic Magazine* 23 (1912) 313–367.

little or no damage to the vegetation on the island. In 1874 there was an eruption during which the entire island was covered with "ashes."

Plate IV is a relief map of Volcano Island previous to the eruption in 1911. The chief change in the physiography wrought by this eruption was within the crater, the center of which is now occupied by a single lake.

FORMER VEGETATION

The only publication that we have been able to find, relating to the vegetation of Volcano Island previous to the eruption of 1911, is a list of 236 species given by Centeno,[4] which he says were collected between the years 1877 and 1879 and were named by Fernandez-Villar. Centeno gives no account of the vegetation, but says that many other plants, mostly grasses and sedges, were growing on the island. The species enumerated are common and widely distributed in cultivated areas, waste places, or second growth forests and are characteristic of cultivated regions at low altitudes in the Philippines. A consideration of the present flora of Volcano Island and that of the neighboring mainland indicates that Centeno's list must have been very incomplete. The first botanist to visit Taal Volcano was Adalbert von Chamisso, of the Romanzoff Expedition (1815–1818), who appears to have left no account of the vegetation of Volcano Island as it then appeared.

No description of the vegetation that existed on the island previous to the last eruption is on record, but a number of Philippine botanists, including Doctors Copeland, Shaw, and Foxworthy and Mr. Merrill, visited the island before the eruption. Their descriptions agree and enable us to form a fair idea of the general type of vegetation.

The main part of the island was covered with a mixture of small trees and grass, the latter being largely *Saccharum spontaneum*. The most prominent tree was a form of *Ficus indica* with small leaves, which was abundant in ravines on the lower slopes of the volcano. On the volcano itself there were scattered tufts of grass, while the rim was bare. The above description of the island agrees very well with photographs that were taken in 1908–1909 and are on file in the Bureau of Science.

The island was subject to very rapid erosion. Radiating

[4] Centeno, J., Estudio Geológico del Volcán de Taal. Madrid (1885) 1–53, *pl. 1–4*.

from the main crater were many very prominent stream beds, which apparently contained water only during heavy rains. These widened rapidly as they approached the shore, forming large deltal fans. The photographs show very clearly that these fans were almost devoid of vegetation. Southwest of and near the main crater is a prominent cone, Mount Tabaro. Judging from the photographs this appears to have been much eroded and quite bare; it is probable, however, that various small clumps of grass were scattered over it. *Plate V, fig. 1,* is a photograph of the main cone of Taal Volcano and Mount Tabaro, taken in 1909. In the center of the picture is the prominent gully running southwestward from the main cone toward Mount Saluyan. The view is toward the north. On the main cone and in the gully there was certainly very little vegetation.

On the low ridges between the dry stream beds the vegetation, grass and trees, came down to the edge of the water in many places. *Plate V, fig. 2,* is a view (1908) of the west side of the island and seems to show that trees predominated in this limited area. The upper part of the main cone appears to be entirely bare. *Plate VI, fig. 1,* also of the west side, shows grass at the edge of the water with most of the trees farther inland. This was taken during the period of activity in 1911 and on the day of the chief eruption which destroyed the vegetation.

Trees predominated in certain localities on Mount Binintiang Malaqui. *Plate VI, fig. 2,* is from a photograph taken of this cone in 1909.

A consideration of the cultural conditions on Volcano Island, previous to the last eruption, throws further light on the nature of the vegetation at that time. On the island there were seven villages. Six of these were located at the northern end and one on the southern coast. Only a small portion of the area was cultivated, but many cattle, carabaos, and horses grazed on the island. The meager description which we have of the vegetation indicates that it was similar to that occurring on the mainland in places where the cultural conditions were similar. This is a common type of vegetation in the lowlands of Luzon in places where the original forests have been removed and consists of a mixture of grass land and small second-growth trees. It can best be designated by the local name *parang,* which has been used in this sense by Whitford,[5] but was erroneously applied

[5] Whitford, H. N., The forests of the Philippines, *Philip. Bur. Forestry Bull.* 10 (1911).

by Vidal [6] to the small second-growth forests that are widespread in the Archipelago. For descriptions of successions on areas from which the virgin forest has been removed see Whitford [7] and Brown and Matthews.[8] Parang is usually the result of human activity, but on Volcano Island volcanic eruptions may have been a contributing factor.

Parang generally originates in the following manner: When the original forests are removed and the land cultivated, but not intensively, grasses—particularly *Saccharum spontaneum* and *Imperata exaltata*, tree species, and weeds make their appearance in large numbers. These are frequently removed by burning, which destroys practically everything except the underground stems of the grasses so that with repeated fires the grasses soon form a solid stand. As the tall, coarse grasses make very poor forage, grass areas are frequently burned to secure young shoots for grazing animals. Wantonly set fires are also frequent. On Volcano island the two latter classes of fires were probably more frequent than those set to clear the land for cultivation. All three classes of fires, of course, produce the same effect.

Where there are no fires, trees occur; and the latter come into the grass when fires are absent for a short period. When the trees begin to form a dense stand, they are again cut down and the above processes are repeated. In this way large areas that are not intensively cultivated become covered with a mixture of trees and grasses. The trees are very different from those of the original forest. They are small, attain a height of about 10 meters, grow rapidly, and are very intolerant of shade. The specific composition is very varied.

In order to obtain an idea of the probable composition of the parang on the island before the last eruption we examined a long strip of the mainland on the western shore of the lake. The principal grass was *Saccharum spontaneum* (talahib). Where the soil was very shallow, the most prominent tree was *Acacia farnesiana* (aroma). On the hills the composition was very complex, but the most numerous tree species appeared to be *Pithecolobium dulce* (camanchíle), *Eugenia jambolana* (du-

[6] Vidal, D. S., Catálogo Metódico de las Plantas Leñosas Silvestres y Cultivadas observadas en la Provincia de Manila (1880) 9, 10.

[7] Whitford, H. N., *Philip. Bur. Forestry Bull.* 10 (1911).

[8] Brown, W. H., and Matthews, D. M., Philippine dipterocarp forests, *Philip. Journ. Sci. A* 6 (1910) 413–561.

hat), *Tabernaemontana subglobosa* (pandacaqui), and *Ficus hauili* (hauili). The shrub *Tabernaemontana pandacaqui* (pandacaqui) and the coarse herb *Blumea balsamifera* (sambong) were also very common. The above plants were probably prominent in the former vegetation on Volcano Island.

Near the small villages perennial cultivated plants such as bananas, bamboo, and fruit trees must have been numerous. Some of the land was probably also intensively cultivated with shorter-lived crops.

The above discussion indicates that parang probably existed on all parts of the island except in the following places: The neighborhood of the villages, where cultivation was fairly intensive; on the steep slopes of the main volcano and Mount Tabaro; and in the stream beds. In some places the growth may have been dense enough to justify its being called a second-growth forest.

DESTRUTION OF VEGETATION

Extensive accounts of the eruption of 1911 have been given by Pratt,[9] Saderra Masó,[10] Worcester,[11] and Martin.[12] These writers agree in saying that the vegetation was completely destroyed. Martin writes:

> Taal Island was devastated, not a blade of grass escaping: trees 15 centimeters in diameter were broken, leaving stumps 0.3 to 0.5 of a meter high; the ends of these stumps were shredded like whisk brooms by the fall of sand and small stones driven by the force of the eruption.

The following description by Masó includes some of the mainland on the western shore of Lake Bombon, or Taal:

> Within the central area which contained 13 barrios and hamlets constructed of bamboo and nipa, the effects are described better by the world 'annihilation' than 'destruction'—human beings, animals, trees, houses, everything was wiped out and covered with a layer of mud out of which only here and there protrudes the trunk of one of the mightier trees!

During the eruption there was no flow of lava and the destruction was not caused by fire. Pratt says:

> The chief agent of destruction and the main cause of death resulting from the eruption was the explosive expansion of the escaping steam, which

[9] Pratt, W. E., The eruption of Taal Volcano, January 30, 1911, *Philip. Journ. Sci. A* 6 (1911) 63–86.

[10] Saderra Masó, M., The Eruption of Taal Volcano, January 30, 1911. Weather Bureau, Manila (1911) 1–45.

[11] Worcester, D. C., *National Geographic Magazine* 23 (1912) 313–367.

[12] Martin, C., Observations of the recent eruption of Taal Volcano, *Philip. Journ. Sci. A* 6 (1911) 87–91.

was violent owing to its movement and suffocating owing to its heat, its burden of mud, and a content of sulphur dioxide.

This blast broke the trees and ground the bark to shreds (*Plate VII, figs. 1 and 2*). Pratt says:

The odor of sulphur dioxide was strong during the eruption and probably this gas or its oxidation product was effective in killing vegetation.

The fall of ash was apparently not particularly heavy. According to Pratt—

The greatest fall of material within the devastated area was on the west slope of the volcano. The maximum thickness of 2 meters noted here occurred where the ash and small fragments had drifted into an old water course. However, the ridges adjacent were all but bare, and therefore an estimate of 20 to 30 centimeters for the average maximum depth of fall for this vicinity is probably reasonable.

Concerning the temperature of the ejecta he writes:

With the exception of the small number of incandescent stones, ejecta from this eruption were apparently not much hotter than boiling water.

The mud appears to have been very injurious to vegetation as is shown by the following statement made by Cox:[18]

While a considerable amount of coarse material fell on the island, the mud that was carried to a distance was comparatively finely divided, and in this respect not greatly unlike road dust. The mud was cool wherever its fall was observed, and it descended in the manner of rain, without violence. Leaves retained only a thin coating on their upper surfaces, yet within a few hours many of them had fallen. Ordinary road dust may fall on plants to any thickness without serious injury.

Cox gives an analysis of ash collected on the island shortly after the eruption. According to this writer, nothing was found that should be injurious to plants. He believed, however, that this analysis did not give a correct idea of the composition of the ash at the time of its fall, and says that there were two possible sources of injuries to plants, namely, sulphuric acid and large quantities of salts of iron, which are often popularly called sulphur. These salts give free acid by hydrolysis when in solution. Worcester lays great stress on injuries done by acid.

Subsequent examination of the island showed that the vegetation was very largely destroyed. In the extreme northern part the destruction was less complete than elsewhere. *Plate VIII, fig. 1*, shows the site of the former village of Pirapiraso just after the eruption. The town is obliterated, while the aërial parts of the vegetation appear to be dead. The ground on the steeper

[18] Cox, Alvin J., The composition of the fine ejecta and a few other inorganic factors of Taal Volcano, *Philip. Journ. Sci. A* 6 (1911) 93–97.

slopes is apparently, not deeply covered with ash. Near the former villages in this northern region a number of clumps of bamboo of two different species and bananas of three varieties have regenerated from the old root stocks. Both of the bamboos, *Bambusa blumeana* and *B. vulgaris*, are introduced species that in the Philippines are not known to spread except through the agency of man. The last statement also applies to two of the varieties of banana. The influence of the bamboos and bananas on the invading vegetation, therefore, should be very slight. The number of clumps of bamboos and bananas, that survived indicate, however, that the root systems of a number of trees might likewise have remained alive and that some of the trees at present on the island may have sprung from these. This is particularly true, since it is characteristic of many parang species to spring up from the ground after the aërial parts of the plants have been killed. A few individuals of the following species of trees appear to have survived the eruption:

Trema orientalis.	*Eugenia jambolana.*
Moringa oleifera.	*Ceiba pentandra.*
Pithecolobium dulce.	*Cratoxylon blancoi.*
Semecarpus cuneiformis.	*Sterculia foetida.*
Ficus indica.	*Annona reticulata.*

It is almost certain that other species survived; although this cannot be demonstrated, as after a few years root sprouts are not easily distinguished from plants produced by seeds. It is only when an exceptionally large stem, broken off above ground, has regenerated or where, as in the case of the bamboos and bananas, no seeds are produced, that we can be sure a plant has survived the eruption. In the vicinity of the village on the southern coast of the island no bamboos or bananas and probably no trees have regenerated. In conclusion we may say that, with the possible exception of the extreme tip of the peninsula at the southwestern corner, the destruction of the vegetation was probably complete on the southern and central parts of the island. Near the northern coast many root systems and probably some seeds escaped.

REVEGETATION OF CLEARED AREAS

Before describing the revegetation of the island, it may be of interest to discuss briefly the vegetation that invades areas from which forests have been removed and the land not cultivated.

In northern Negros large areas of virgin dipterocarp forests on the banks of Himugaan River have been logged by a lumber

company. The removal of the main canopy has resulted in the destruction of the undergrowth. The land was very quickly invaded by a small second-growth forest of a type that is entirely different from the original vegetation. *Trema orientalis* (anabion) is by far the most prominent tree, and in many places it forms practically pure stands. Associated with it are, however, a large number of other second-growth tree species.

Also on Mount Mariveles in Bataan Province, Luzon, a large area of virgin dipterocarp forest has been destroyed by logging. The ground was very quickly invaded by a second-growth forest similar to that in northern Negros, except that here the principal tree species is *Homalanthus populneus* (balanti). In neither of the above regions was a second-growth forest preceded by grass. On Mount Mariveles no species, other than trees, was prominent in the early stages of invasion. In northern Negros a wild banana was abundant, but no small species was conspicuous.

The succession in these two areas appears to be typical of that which occurs in similar places in the Islands in general. For a more extensive discussion of cleared areas see Brown and Matthews.[14]

The invasion of cleared areas may be summarized as follows: When forests are removed and the land not cultivated the ground, within one or two years, is covered by a second-growth forest in which, frequently, one species is much more prominent than any other. The dominant species invariably have a rapid rate of growth.

Cultivation that is not intensive usually results in the formation of grassland or parang. This process has already been discussed.

REVEGETATION OF VOLCANO ISLAND

The progress of revegetation on Volcano Island has been very different from that described above for lands cleared of vegetation and afterward not cultivated. The chief invading species have been grasses, and revegetation has been so slow that in most parts of the island the ground, after nearly six years, is only sparsely covered.

Our knowledge of the early stages of revegetation of Volcano Island is due to Gates,[15] who visited the volcano in October and December, 1913, and in April, 1914.

[14] Brown, W. H., and Matthews, D. M., *Philip. Journ. Sci. A* 6 (1911) 413–561.

[15] Gates, Frank C., The pioneer vegetation of Taal Volcano, *Philip. Journ. Sci.* 9 (1914) *Bot.* 391–434, *pl. 8–10*.

Gates gives a very short account of the progress of revegetation during 1911 and 1912. He did not visit the island until October, 1913, and does not give his source of information, the reliability of which is questionable as we know of no trained botanists who visited the Island during that period and the remembrance that untrained men have of their casual observations is likely to be very poor evidence on a subject of this kind.

In October, 1913, Gates found a wide strip of vegetation across the northern end of the island and also some vegetation at the extreme end of the peninsula at the southwestern corner. In many places, even in the above regions, the vegetation was very scanty. The remainder of the island was without plants. The vegetation seems to have consisted largely of a tall, coarse grass, *Saccharum spontaneum*, although trees and other plants were present in considerable numbers. The growth of *Saccharum* was apparently fairly dense in certain localities at low elevations. In describing these Gates says:

> At lower elevations the bunches occur nearer together until a fairly dense stand occupies the lower slopes, yet even in these places the great growth activity has not yet succeeded in obliterating the bunch-grass habit and covering the ground.

The early appearance of vegetation in the northern part of the island is probably connected with the fact that here the effects of the eruption were less severe than elsewhere.

Gates found no evidence to show that any of the grass had sprung from clumps existing previous to the eruption. His first visit was two and a half years after this event, so it is hardly to be expected that any such sign would have been noticeable. Probably most of the grass in this region was killed, but it seems quite possible that scattered clumps may have survived as this grass has characteristic, deep-seated rhizomes. *Saccharum* seeds during both monsoons. Therefore, if all of the first plants of *Saccharum* grew from seed coming from the mainland, we would hardly expect it to form such dense stands in a limited area and to have been so circumscribed in its early distribution. In localities where Gates found *Saccharum* occuring as scattering clumps in 1913 and 1914 this plant does not even now form dense stands nor do the individual clumps appear to have reached mature size. This would indicate that the dense stands of grass that Gates found in 1913 and 1914 would have required more than three years to develop from seed. Such clumps as survived may very well have been reduced in size to small tufts. Unfortunately the only observations on the revegetation of Taal

previous to 1913 were made from a distance of many kilometers, whereas in our experience we have found that even at a distance of less than a kilometer it is impossible to tell whether or not small tufts of grass or other small plants are present on an area.

When Gates visited the island in April, 1914, the vegetation had spread over a much larger area than it occupied in 1913. Most of the land on the part of the island north of the main crater supported plants, while vegetation had spread over the whole southwestern peninsula as far as the top of Mount Saluyan. A narrow strip of vegetation had also appeared along the eastern coast. In the area invaded between October, 1913, and April, 1914, the vegetation was apparently very sparse on the latter date. Vegetation was also still scarce on much of the land that supported plants in 1913.

GRASSES

Until now (January, 1917) by far the most prominent invading species has been *Saccharum spontaneum* (talahib), which is scattered all over the island. In a few limited areas in the northern part it forms dense stands. Elsewhere it occurs as scattered clumps. On the lower gentle slopes these clumps are fairly large and well developed. In very favorable situations in the Philippines *Saccharum* may reach a height of 4.5 meters, but on Volcano Island it does not attain this size, being rarely more than 3 meters in height. Where it occurs as scattered clumps, it is even smaller than this. Except in very limited areas it is easily possible to walk between the individual clumps, and in most places the distance between clumps is considerably greater than the height of the grass. *Plate VIII, fig. 2*, is from a photograph taken near the shore, west of a point between the two old craters on the western side of the island. It gives a good idea of the average development of *Saccharum*. On the steep slopes of the main cone and Mount Tabaro, in the dry stream beds, and on the deltal fans *Saccharum* appears only as scattered, dwarfed tufts, which owing to the rapid erosion lead a very precarious existence. *Plate XIV, fig. 1*, shows a wide deltal fan with a narrow stream bed extending through it. These fans are almost devoid of vegetation. Over long stretches in the central and southern part of the island there is very little conspicuous vegetation other than *Saccharum*.

Near the coast in some of the open places between the widely separated clumps of *Saccharum* there are various scattered plants of small grasses and sedges. The most conspicuous of these

grasses have a running habit. These grasses and sedges are so small and scattered that even at a short distance they are not noticeable and the ground that they occupy appears to be quite bare. An exceptional development of them is shown in *Plate VIII, fig. 2.*

In the extreme northern part of the island and at the tip of the peninsula, which projects from the southwestern corner, there are some very steep slopes. In these places another tall grass, *Themeda gigantea,* predominates; and erosion is apparently not very rapid at the present time. *Themeda* is confined largely to the various steep slopes, which are at a considerable distance from the crater, and in such places it makes a better growth than *Saccharum.* At the present time *Themeda* occurs mostly in dense stands. It is most prominent on Mount Binintiang Malaqui and the neighboring horseshoe ridge, Mount Balantoc. In both of these places the stands are frequently so dense that it is extremely difficult to walk through them.

In a limited region in the northeastern corner of the island, between Mount Bignay and Mount Ragatan, and at the northwestern corner near the former village of Pirapiraso, *Imperata cylindrica,* a much smaller grass than either *Saccharum* or *Themeda,* covers the ridges and some of the slopes. The valleys in this region are occupied by *Saccharum. Imperata cylindrica* is a very common grass on the mainland around Lake Bombon, and so it seems surprising that its distribution on Volcano Island should be so limited. This is particularly so, because *Imperata* usually occurs on dry ground. On the parts of Volcano Island where *Imperata* and *Saccharum* occur together, they occupy the same relative positions that they usually do on the mainland; that is, *Imperata* in the drier and *Saccharum* in the moister situations. However, in other parts of the island *Saccharum* occurs in situations that appear to be dryer than those occupied here by *Imperata.*

Another case of a peculiar distribution of a grass is afforded by *Miscanthus sinensis.* This tall grass usually occurs at high altitudes in places where the soil is moist and the evaporation low. In such situations it frequently forms extensive dense stands, which result from fires in the same manner as do those of *Saccharum spontaneum* at low altitudes. On Volcano Island this grass is mainly confined to small patches, which occur on the sides of the ravines and are frequently only a few meters above sea level. The total area occupied by this grass is very small.

The very open nature of the stand of grass on most parts of the island is certainly not due to competition and apparently not to a lack of seed. *Saccharum, Imperata,* and *Miscanthus* have adaptations for the distribution of the seed by wind, and the first two certainly produced large quantities of seed on the island as early as three years ago.

The failure of grass to produce dense stands even in most places where it occurred as scattered patches in 1914 would indicate unfavorable environmental conditions. This view is supported by the reduced height of the clumps of *Saccharum.*

TREES

Trees are very scarce except in limited areas near the northern coast and at the extreme tip of the peninsula that extends from the southwestern corner. Even in these localities grasses are very much more prominent than trees Elsewhere the trees occur only as very widely separated individuals or as clumps of two or three individuals. *Plate XI, fig. 1,* is from a photograph taken at the northwestern end of Mount Balantoc and shows an exceptional development of trees.

The only area in which trees predominate is on the northern slopes of Mount Pirapiraso, at the northwestern corner of the island, where the second-growth forest reaches its greatest development and covers more than half of the area, the remaining space being largely occupied by grass.

The specific composition of the tree flora of Volcano Island is extremely varied when the small number of the individuals is considered.

The most abundant species is *Acacia farnesiana* (aroma), which is scattered over the whole island except on the main cone and Mount Tabaro. This plant is very common on the mainland around Lake Bombon, and in the Philippines generally it is prominent in the early stages of invasion of grasslands by trees. Its success in the latter situation is due to its ability to regenerate after the aërial portions of the plant have been killed by fire. In view of this habit and its present prominence on the island it seems not unlikely that a considerable number of plants of this species may have escaped destruction during the eruption of 1911. On the other hand the seeds of aroma are inclosed in a woody pod which floats so that it may readily have been washed ashore; in which case, however, we must account for its distribution in places distant from the shore. The method by which

it has been distributed all over the island is not evident, as it is apparently not adapted to be eaten by birds or for wind dispersal.

The next most prominent tree is a small variety of *Ficus indica*. In favorable situations on the mainland this tree reaches a fairly large size, in many cases being 15 meters in height. The trees on Volcano Island are smaller and the tallest probably average about 7 meters. This was about the height of the largest individuals on the island previous to the eruption of 1911.

In the northern part of the island trees of this species were observed that had apparently sprouted from old stumps. *Ficus indica* is well known as a tree with a very irregular habit of growth. This plant, like most of the irregular-growing figs, is very tenacious of life; and it seems probable that its presence in large numbers is due, in part at least, to individuals that were not destroyed by the eruption, as *Ficus indica* is not abundant on the mainland. However, the seeds of this plant might be readily dispersed by birds. *Ficus indica* is particularly prominent on the main crater, as it is practically the only tree species that occurs on this cone. However, the number of individuals found here is small, and they are confined largely to the ravines on the lower slopes. Within the crater *Ficus indica* is represented by a single specimen on the northern wall, while several individuals were found at the edge of the crater.

Next to the above the most prominent tree species are:

Eugenia jambolana (duhat).
Trema orientalis (anabion).
Tabernaemontana subglobosa (pandacaqui.)
Morinda bracteata (tumbong aso).
Pithecolobium dulce (camanchíle).
Antidesma ghaesembilla (binayuyo).

It will be seen that this list of common species is very similar to that previously given for the mainland. The seeds of all of these trees are distributed by birds.

The tallest trees and the densest stands of tree species are found near the northern shore. The presence of plants that survived the eruption and better soil conditions undoubtedly account in part for the greater density of tree vegetation found here. Some of the most prominent tree species in this region escaped distribution during the eruption, as is shown by the presence of individuals growing from old stumps. This has been observed in the case of *Ficus indica, Eugenia jambolana,*

and *Trema orientalis;* and, as we have seen it may very well have been true of *Acacia farnesiana.*

All of the trees of any prominence occuring on the island are characteristic of parang. They are small species, which have a rapid rate of growth and mature early. *Acacia farnesiana* and *Tabernaemontana subglobosa* might perhaps be as well termed shrubs as trees, but for convenience we have used the latter term. The small size of the trees can be seen from the data given in Table I, which is compiled from Merrill's Flora of Manila.[16]

TABLE I.—*Mature height of common trees on Volcano Island.*

Species.	Height in meters.
Ficus indica	4–12
Acacia farnesiana	2–4
Eugenia jambolana	4–15
Trema orientalis	5–8
Tabernaemontana subglobosa	2–5
Morinda bracteata	3–10
Pithecolobium dulce	5–18
Antidesma bunius	4–10
Antidesma ghaesembilla	4–10

Owing to the rapidity with which most of the tree species mature, large quantities of seed have already been produced on Volcano Island. Many of the species frequently produce seed when much less than 1 meter in height. We have seen that most of the prominent trees have fruits that are readily scattered by birds. As an illustration of the facility with which seeds are distributed in this way, we may mention a case observed in a clearing of 0.25 hectare on Mount Maquiling at an altitude of 450 meters. In a few months the ground was covered by a second-growth forest consisting largely of *Trema orientalis.* The nearest observed plants of this species were about 3 kilometers distant and approximately 250 meters lower in elevation. There were certainly few if any individuals nearer than this, as the clearing was made in the center of the virgin forest, and *Trema* is so intolerant of shade that it will not grow under the cover of even the most open second-growth trees.

It seems from the above that enough seeding must have taken place on Volcano Island to produce a denser tree vegetation than that which now exists. Moreover, the scarcity of any particular species or of trees in general is certainly not due to competition,

[16] Merril, E. D., A Flora of Manila. Manila (1912) 1–490.

but apparently must be referred to unfavorable external conditions. These factors will be considered later.

SHORE VEGETATION

One of the most interesting features in the distribution of plants on the island is that of *Ipomoea pes-caprae.* This plant is a spreading vine, which usually forms a part of the strand formation on sea beaches. It occurs as occasional patches on the mainland shore of Lake Bombon where it is sometimes mixed with *Canavalia lineata,* a leguminous species of similar habit. While the leaves of *Canavalia* are compound and those of *Ipomoea* are simple, nevertheless the texture and the color of the leaflets of *Canavalia* and of the leaves of *Ipomoea* are so similar that it is only by the flowers that the two plants can be readily distinguished at a distance. These two plants occur together in scattered localities along the shore on all sides of Volcano Island, but they are more conspicuous on the slopes inland from the southern and southeastern shores. They have apparently grown over the ash on the southern coast to an altitude and distance as limited only by the period during which growth has taken place. Both have reached a vertical height above the lake of more than 50 meters, while *Ipomoea* is prominent more than 0.25 of a kilometer from the coast. Over large stretches of the lower ridges near the coast *Ipomoea* forms a thick carpet between the clumps of *Saccharum.* As the *Saccharum* becomes denser, it will probably replace the *Ipomoea;* as along the northern coast, where the growth of *Saccharum* is thicker, *Ipomoea pes-caprae* is confined to the beach and does not occur inland.

Ipomoea is particularly abundant near the southern and eastern coast and on the peninsula that extends from the southwestern corner and to a less extent around the base of Mount Binintiang Malaqui. Except in the two last-named regions *Ipomoea* and *Canavalia* are represented on the western coast by only a few scattered plants. This is apparently due to the presence of numerous wide deltal fans on this side of the island. In *Plate IX, fig. 1, Ipomoea* is shown growing near the water's edge, but more abundantly on the more elevated ground where it is mixed with *Saccharum. Ipomoea* grows on the mainland in an area made swampy by fresh-water springs. This distribution is apparently not connected in any way with a high salt content of the soil.

Gates [17] in describing this vegetation in 1914 says:

> *Canavalia* tends to extend inward away from the water to a very much greater extent than *Ipomoea,* which is usually confined to the shore. Exceptions occurred on the lava ridges of Mount Binintiang Munti, where *Ipomoea* spread a considerable distance from the shore, and in a few places on the eastern side of the island, where unaccompanied with *Canavalia, Ipomoea* spread back several meters and attained an altitude of about 30 meters on the mud slope.

FERNS

At low altitudes there are many ravines from 2 to 3 meters in depth and less than 1 meter in width. On the northern slopes these ravines have developed into veritable cañons, often with perpendicular walls many meters in height. In these there is frequently a considerable development of a fern flora and a few species of mosses and hepatics. The most prominent ferns are:

Acrostichum aureum.
Ceropteris calomelanos.
Nephrolepis biserrata.
Pteris vittata.
Pteris quadriaurita.
Onychium siliquosum.
Odontosoria chinensis.
Blechnum orientale.
Cheilanthes tenuifolia.
Adiantum philippense.

AQUATIC VEGETATION

We have made no special study of the aquatic vegetation around the island. Our knowledge of this was obtained from observations made while walking around the whole shore of the island, except an inaccessible portion at the base of Mount Binintiang Malaqui, and while bathing at a number of different points.

On some of the rocks there is a considerable growth of *Cladophora,* but this was the only attached vegetation observed with the exception of two small plants of *Vallisneria gigantea,* the roots of which were half exposed by the action of the waves. Along the northern shore were found a considerable quantity of broken *Vallisneria* and a single piece of *Ceratophyllum demersum* that had been cast up by the waves. Occasional plants of the floating aroid *Pistia stratiotes* were observed at different places along the shore.

ASSOCIATIONS

The vegetation of Volcano Island is not readily divided into formations or associations. This is a natural result of similar external conditions over the whole area and the scarcity of vegetation, which consists, either entirely of *Saccharum,* or of

[17] Gates, F. C., *Philip. Journ. Sci.* 9 (1914) *Bot.* 319–434.

a heterogeneous mixture in which many plants occur in situations very different from those in which they are usually found. The occurrence of patches of *Miscanthus*, a typical high-mountain grass, near the sea level is a conspicuous example. Equally striking is the growth of *Ipomoea* mixed with *Saccharum* at considerable distances from the shore. The scattered patches of *Miscanthus* in an unusual situation can hardly be regarded as constituting an association. The same might be said of *Ipomoea* that is growing between the clumps of *Saccharum*. The scattered plants of *Ipomoea* and *Canavalia* that are found on the beach can hardly be considered as a strand formation. Certainly there is little similarity between the growth composed of these species on Volcano Island and the normal strand formation as found on the sea beach.

The great preponderance of grass on the island seems to justify the classification of the vegetation as an invasion by a grass formation. The principal association of grass is certainly *Saccharum spontaneum*. In some places on the steep slopes *Themeda gigantea* occurs in stands that are pure enough to justify its being classed as a separate association. On the mainland both *Saccharum* and *Themeda* constitute very definite associations.

The tree flora is so scattered and is composed of such a heterogeneous mixture of different species that it is impossible to recognize any clear divisions, and the whole can best be regarded as an early stage of the invasion of grassland by a second-growth forest formation. The prominent species are all small, and all are characteristic of the early stages of the invasion of grassland or other open areas by trees in many parts of the Philippines. Second-growth forests should give place to the tall dense forests characteristic of this region. In this process there must be a number of stages or successions. Our knowledge of these successions is very fragmentary at present, so that the different stages cannot be described. However, on Taal there seems to be no indication of a second stage, as all the species of any prominence are characteristic of the very first stages of the invasion of grassland or other open areas by second-growth forest. Gates [18] divides the invading trees and shrubs into two formations. One of these he calls the parang, or shrub-small-tree, formation and the other, the low-altitude tree formation. In each of these he recognizes a single association. The first is the

[18] Gates, F. C., *Philip. Journ. Sci.* 9 (1914) *Bot.* 391–434, *pl. 8–10.*

parang association and the second, the *Bambusa-Parkia* association. The latter according to Gates succeeds the former.

Gates says very little about his reasons for making this division, which, with modifications, is an attempt to follow Whitford [19] in his description of a very different type of vegetation in an area that unfortunately was not visited by Gates. The division as applied to Volcano Island does not seem to be justified, and the choice of names is unfortunate.

While Gates does not so state, it seems evident that he did not intend to imply that his *Bambusa-Parkia* association was the same as that described by Whitford, but he simply used the term in a very broad sense to denote lowland forests. Whitford's [20] *Bambusa-Parkia* formation, described from the base of Mount Mariveles, consisted of a mixture of bamboo and trees and was regarded as a climax formation. Since Whitford's paper was written, a large area of dipterocarp forest in this region has been logged by a lumber company and has changed to the *Bambusa-Parkia* type.[21] The characteristic bamboo *Schizostachyum mucronatum* (boho), a native species smaller than *Bambusa blumeana,* occurred as scattered clumps in the dipterocarp forest. After the forest was logged, these spread until in many places *Schizostachyum* formed almost pure stands. The large trees of which *Parkia* is a representative are, for the most part, relics of the former forest, which were left because they were not of sufficient value to be removed. Only two of the trees mentioned by Gates as belonging to his *Bambusa-Parkia* association are given by Whitford in his list of the eighteen prominent trees in this association.

The bamboo of Gates's association is *Bambusa blumeana,* which has regenerated from rootstocks that were present before the eruption and were not killed by the covering of mud and ashes. In the Philippines this bamboo is a cultivated form, which rarely, if ever, forms new clumps except where planted, and therefore it cannot be considered as part of an invading association.

Gates's *Bambusa-Parkia* type is certainly very different from that described by Whitford. Gates gives such a brief description that his conception of it is not clear, and we are unable to identify it with any of the usual types found in the Philippines. When Gates mentions the occurrence of this type, he evidently

[19] Whitford, H. N., *Philip. Journ. Sci.* 1 (1906) 373.
[20] Whitford, H. N., loc. cit.
[21] Brown, W. H., and Mathews, D. M., *Philip. Journ. Sci. A* 9 (1914) 457.

refers not to what he considers a typical development of it, but to the presence of scattered individuals representing it. The plants listed seem to be a heterogeneous collection whose different members would not be prominent in the same habitat.

We have shown that the name "parang" is properly applied to a mixture of grass and second-growth trees. In his use of this term Gates followed one of Whitford's earlier papers in which the latter in turn followed Vidal.

Gates described three moist-ground, or marsh, associations of grasses and a "back strand association" of *Sesbania*, all occurring along the coast, apparently on the deltal fans, or at the foot of bluffs. Owing to the rapid erosion on the island such plants would necessarily lead a very precarious existence. As we found no traces of such vegetation, it seems probable that they had been either washed away by water from the lake, or destroyed by floods on the deltal plains. The chief plants of these associations were found only as widely scattered individuals. For example, Gates describes a *Sesbania* strand association as occurring in several localities and as rapidly invading the *Ipomoea pes-caprae* association. In 1916–17, we found only a single seedling of *Sesbania* on the island.

REGIONAL DESCRIPTION

The discussion of the vegetation that existed on the island in 1913 and 1914 is based on Gates's [22] description and pictures. Owing to a lack of exactness in his statements it has been difficult, in some cases, to interpret Gates's account. Thus he says (p. 395):

> By December, 1913, vegetation was quite well established on the northern side of the island to an altitude of about 175 meters. If consisted largely of grass—entirely dense at low altitudes, * * *.

What he means when he says "entirely dense" is not evident, as *Saccharum* is the principal grass and in describing the "Saccharum consocies" he says that even at lower elevations the growth activity has not "succeeded in obliterating the bunchgrass habit and covering the ground." *Saccharum* is usually about as high as a man and is normally so dense that it is exceedingly difficult to force a way through it, even for a short distance. In January, 1917, the growth of *Saccharum* in the northern part of the island was so open that, except in very limited areas, one could readily pass in any direction over the whole region and along the shore of the lake without the slightest

[22] Gates, F. C. *Philip. Journ. Sci.* 9 (1914) *Bot.* 391–434.

difficulty. When Gates mentions the occurrence of tree vegetation he evidently refers in almost all, or in all, cases to a distributional stage in which the trees are scattered.

FIG. 2. Areas on Volcano Island invaded by plants in 1913 and 1914.

While some of Gates's statements are inexact, we believe that with the help of his pictures and a knowledge of the present vegetation of the island we have interpreted them correctly. *Text fig. 2*, a map taken from Gates's paper, shows the areas in

which vegetation occurred in 1913 and 1914. The relative abundance of the vegetation in different regions is not indicated on the map.

As the revegetation began at the northern end of the island, we will begin our discussion with that area.

The northwestern corner of Volcano Island is formed by Mount Binintiang Malaqui whose summit is more than 250 meters in height, which with the exception of the southwestern rim of the crater is the highest point on the island. The slopes of this peak are very steep, and the valleys are rather shallow. Gates found that on the greater part of the slopes and always on the steeper ones *Themeda gigantea* occurred as open well-spaced clumps. On the sides of the valleys bushes were frequently present, while on the northwestern side, away from the crater, trees from 4 to 5 meters in height were found. The chief change since Gates's visit seems to be that the *Themeda* has become much thicker and in many places forms solid stands, while the trees have increased in size and probably also in number. The predominant vegetation is *Themeda*. Mixed with this is a much smaller amount of *Saccharum*, while trees are few and much scattered. *Plate IX, fig. 2*, shows Mount Binintiang Malaqui from Gunao Point. The dark spots are the trees. The number of trees shown here is very similar to that found on the northern slopes. A comparison with *Plate VI, fig. 2*, shows that trees are very much less prominent than before the eruption.

Southeast of Mount Binintiang Malaqui is a prominent horse-shoe ridge, Mount Balantoc. On the northern and northeastern slopes of this mountain Gates found trees mixed with *Themeda gigantea*. In this region *Themeda* and *Saccharum* now form dense stands, while trees are prominent in the ravines. The trees are present in sufficient number to give character to the vegetation, but nowhere do they form stands dense enough to kill the grass. The vegetation can best be classified as parang in which the grass covers at least twice as much area as the trees. *Plate X, fig. 1*, is from a photograph by Gates and shows Mount Balantoc in the foreground. Gates evidently meant only that woody plants were prominent when he said that this region "was largely wooded." The remainder of Mount Balantoc is now covered with an open growth of *Saccharum* while trees are prominent in the ravines. *Plate XI, fig. 1*, is from a photograph taken on the southern slope of the northwestern end of this mountain. The spacing of the *Saccharum* and the number of trees are shown very clearly. In the distance the grass appears

to be much denser than in the foreground; this appearance is deceptive, as in reality the grass is no thicker on any part of the slope than in the foreground. *Plate X, fig. 1,* is from a photograph taken by Gates in April, 1914, of another portion of Mount Balantoc where the vegetation at present is very similar to that shown in *Plate XI, fig. 1.* A comparison of these two views indicates that the revegetation since 1914 has not proceeded as rapidly as would be expected if the vegetation seen by Gates in the northern part of the island had been entirely new.

The low divide separating Mount Balantoc and Mount Binintiang Malaqui is covered by an open stand of *Saccharum* and scattered trees. Bananas and bamboos are present in the vicinity of the old villages. All of the bamboos have probably regenerated from old rootstocks. One of the varieties of banana appears to be spreading to a slight extent. Plants of *Saccharum* and trees are more numerous than when Gates visited the island, but as might have been expected there is no evidence of any increase in the number of clumps of bamboos. It is interesting that in October, 1913, Gates found only three clumps of bananas and no clumps of bamboos. "In April, 1914, bananas were fairly abundant and indicated quite well the positions of many of the former houses," while bamboos were prominent. This would indicate that bananas and bamboos could remain alive for a considerable period of time without showing any activity above the ground.

In 1914 the vegetation was fairly well developed in the area partly inclosed by Mount Balantoc. This is now covered by an open growth of *Saccharum* and scattered trees.

Plate XI, fig. 2, is a view of the northwestern part of the island from the junction of Mount Pinag-ulbuan with the crater rim. Mount Balantoc and Mount Binitiang Malaqui appear in the distance.

The northeastern corner of the island is formed by a peninsula containing Mount Pirapiraso and Mount Bignay. In this region Gates found the densest vegetation that occurred on the island in 1914. His photograph of Mount Pirapiraso and Mount Bignay seems to show that here grass predominated, while scattered trees were fairly abundant. The grass, however, had apparently not reached its normal density, as Gates in discussing areas covered by *Saccharum* says that even on low slopes the bunch-grass habit had not been obliterated. At the present time the ground except in a few localities is densely covered by a mixture of grass and trees. The trees occupy about as large

an area as the grass, and on the north slope of Mount Pirapiraso the trees cover more than 50 per cent of the ground. A comparison with Gates's pictures indicates that trees are now more numerous in this region than in 1914. Their greatest development is in the ravines. Scattered clumps of bamboos also occur in this locality. The latter are apparently the same ones that were seen by Gates. In this region the second-growth forest is better developed than on any other part of the island, and here we find the most complex vegetation. Many species are found in the immediate vicinity of Pirapiraso that were not observed elsewhere on the island. The thickets are so dense in many of the ravines and on some of the northern slopes, that it is difficult to penetrate them, the bushes and small trees being often overgrown by a tangled mass of herbaceous and woody vines.

On the divide between the former towns of Pirapiraso and Bignay Gates found a stand of *Imperata cylindrica* and *Saccharum spontaneum*. Scattered trees were also present. *Saccharum* has apparently invaded much of the area occupied by *Imperata*, a much smaller grass, and is at present much more prominent than the latter.

Mount Ragatan runs diagonally across the base of the northeastern peninsula. Gates found this rather densely covered with grass, shrubs, and small trees. The grass on the northern slope is now fairly dense. Trees are numerous in the ravines, but scarce on the ridges. On the eastern and western slopes the grass is well developed, but numerous bare strips running with the slope make it fairly easy to penetrate. On the southern slope the vegetation is largely *Saccharum*, which is still open enough to allow one to pass through it readily.

Southwest of Mount Ragatan is a crescent-shaped ridge, Mata-as-na-golod. In October, 1913, the vegetation on this mountain consisted almost entirely of *Saccharum* in clumps and extended about two-thirds of the way to the top. By December it had reached the top. The vegetation in 1917 still consists almost entirely of *Saccharum*, which has not yet formed a stand of its normal density; although on the northern slopes the bare ground occurs only as numerous patches, which usually appear much smaller than a clump of *Saccharum*. On many of the ridges on the southern slopes there are considerable areas that are almost bare. This mountain is the prominent peak in Plate *XII, fig. 1*. It is not clear what Gates meant when he said that a closed stand of *Saccharum* occurred on the western, eastern, and northern

slopes in April, 1914. In discussing the general distribution of *Saccharum* (p. 410) he gives the impression that nowhere did it form stands of normal density.

In the region between Mounts Balantoc and Mataas-na-golod there are two prominent dry stream beds, which in 1914 contained a few plants of *Phragmites*. They are now covered with scattered clumps of *Saccharum*. The remainder of this area contained almost nothing but grass in October, 1913, but by April, 1914, many shrubs were present. *Plate X, fig. 3*, is a view taken by Gates in October, 1913, from near the crater rim and looking northward toward Mount Tibag in the center of this area. The vegetation on the north-central region still consists very largely of *Saccharum spontaneum*, which even now in most places forms a very open stand.

The regions that we have discussed constitute the area in the northern part of the island on which plants occurred in October, 1913. This area is shown in *text fig. 2*, a map taken from Gates's paper, and may be defined as being bounded on the south by a line starting slightly south of Bignay, running south of Ragatan and Mataas-na-golod, then slightly southwest and around the southern end of Mount Balantoc. *Plate XI, fig. 2*, and *Plate XII, fig. 1*, from photographs taken in October, 1916, show nearly all of this region with the exception of the northeastern peninsula and also some of the area nearer the crater. It will be seen that in most places there is a considerable amount of bare ground, while grass is everywhere the predominant element in the vegetation.

By April, 1914, the area containing plants had been considerably extended, plants being found clear to the rim on the northern side of the main crater and somewhat south of the old craters, which are shown on the map east and west of the northern end of the main crater. In 1914 the vegetation in this area was very sparse, and even at the present time the bare ground is many times greater in extent than that covered by plants. The most prominent plant is *Saccharum*, while trees and shrubs are very scarce. In October, 1913, there was a sparse development of plants at the extreme tip of the southwestern peninsula. By April, 1914, this vegetation had spread to the summit of Mount Saluyan, which is about the point where the peninsula branches off from the mainland. This vegetation was apparently very scanty; and even now trees are scarse, while the grass occurs as widely spaced clumps except in very limited areas where *Themeda* forms dense stands on steep slopes. In *Plate XII, fig.*

2, the trees are shown as dark spots. Although the grass forms a very open stand this fact is not evident in the picture, which was taken at too great a distance to show the spacing. The grass consists almost entirely of *Saccharum* except on the steepest slopes at the end of the peninsula where *Themeda* predominates. Over much of this area *Ipomoea pes-caprae* is found between the clumps of *Saccharum* and is particularly well developed at the end of the peninsula, where it grows over the top of the highest ridge.

In 1914 there was also a slight development of vegetation running along the southern shore to a point slightly west of south of the center of the main crater, while along the middle region of the eastern shore there was also a slight development of vegetation. In 1914, however, most of the central and southern parts of the island were without plants.

At the present time the vegetation has spread over the whole island, but is very scanty in the places where there was not a considerable development in 1914. The vegetation characteristically consists of very widely spaced clumps of *Saccharum* with a few scattered trees. *Plate XIII, fig. 1*, which was taken from Calauit Point, looking northwest, gives a very good idea of the density of the vegetation over the southern and central parts of the island. *Plate XIII, fig. 2*, shows both sides of the prominent dry stream bed extending southwest from the crater. On the right are seen the slopes of Mount Saluyan. This shows the character of the vegetation in the southwestern region very clearly. The numerous clumps are *Saccharum*, while the six larger and darker ones are trees. The vegetation is very similar over the whole of the recently invaded area, except that in many places near the southern and southeastern coasts *Ipomoea* has grown inland to a considerable distance between the clumps of *Saccharum*. This development is greater near the western end of the southern coast, where *Ipomoea* is very conspicuous more than a quarter of a kilometer inland.

The dry stream beds and deltal fans are everywhere almost entirely barren. These are most prominent on the western side of the island, particularly that part west and southwest of the main crater where they occupy practically the whole area. This region is particularly bare. *Plate XIV, fig. 1*, shows a view from Pandac-na-lon̄gos Point (*text fig. 2*) west of the main crater, and looking southeast with the main crater in the left of the picture. Most of the view is occupied by a large deltal fan through which there extends a narrow stream bed. The barren-

ness of the area is very evident. In the distance there are scattered clumps of *Saccharum.* On the right is seen a low divide, which separates this fan from the prominent one north of Mount Tabaro. The latter region is very extensive and is the most barren large area on the island, there being only a very few small tufts of grass present. Photographs of this area taken before the eruption indicate a very sparse vegetation at that time.

The photographs of Mount Tabaro taken before the eruption (*Plate V, fig. 1,* left of picture) also indicate that it was bare or supported only scattered clumps of grass. At the present time the only vegetation on it consists of very scattered and dwarfed tufts of *Saccharum.* In the left of *plate XIV, fig. 2* is a view of this mountain. The drainage from the southwestern rim of the crater and Mount Tabaro supported some trees and scattered grass before the eruption (*Plate V fig. 1*). Now only a few clumps of *Saccharum* are present in this area (*Plate XIV, fig. 2*), but the slow revegetation is not surprising in view of the scarcity of plants before the eruption.

The growth of *Saccharum* on the upper slopes of the crater and near the rim consists very largely of scattered dwarfed tufts. The only trees observed here were a few individuals of *Ficus indica* and one of *Acacia farnesiana.* Two ferns, *Nephrolepis biserrata* and *Ceropteris calomelanos,* occur as widely scattered and dwarfed individuals on the outer slopes of the crater near the rim. *Plate XV, fig. 1,* shows the entire rim of the crater from the southeast.

In a limited area on the northwestern wall, a few meters above the floor, there is a sparse development of vegetation consisting of *Erigeron linifolius, Lygodium japonicum, Nephrolepis biserrata, Ceropteris calomelanos, Odontosoria retusa, Onychium siliquosum, Blumea lacera, Fimbristylis squarrosa,* and a single plant of *Neonauclea bartlingii.* Most parts of the inner walls of the crater are too steep to support vegetation, but here and there scattered tufts of *Saccharum* occur. Several trees, probably all of which are *Ficus indica,* occur on the northern wall of the crater. The one shown by Gates [23] is now between 5 and 6 meters high. One individual of the fern *Nephrolepis biserrata* was observed on the inner wall of the crater near the rim. On the floor of the crater there is almost nothing except scattered clumps of *Saccharum.* In a small area in the northwestern part there are, besides the *Saccharum,* scattered tufts of *Mariscus stuppeus* and *Fimbristylis squarrosa. Plate XV, fig. 2,* shows the walls

[23] Gates, F. C., *Philip. Journ. Sci.* 9 (1914) *Bot. pl. 10, fig. 3.*

and the floor of the crater, as viewed from about the southernmost point of the rim.

The preceding discussion shows very clearly that the revegetation of Volcano Island is proceeding in a very different manner and much more slowly than does the revegetation of land from which forest has been removed by logging. We have seen that the first invaders of the latter areas are tree species, and in two or three years the land is covered by a forest composed of small trees. The specific composition of the latter forest is very different from that of the original.

As has been shown, it would seem that both the slow revegetation of Volcano Island and the scarcity of trees should be attributed to adverse environmental conditions rather than a lack of seed.

COMPARISON WITH KRAKATAU

The early stages in the revegetation of Volcano Island have been very different from those on Krakatau. Treub,[24] who visited Krakatau three years after the destruction of the vegetation of that island, found that the new vegetation could be divided into two classes; namely, a strand vegetation, which owed its existence to seeds carried by ocean currents, and an inland vegetation, consisting very largely of 11 species of ferns. According to the observation of Treub, habitats suitable for the growth of fern prothallia were provided by blue-green algae which were very prominent in the early stages of revegetation.

Besides the ferns there were in the interior eight species of phanerograms, two of which also occurred on the strand. The remaining six species, and the previously mentioned ferns were apparently carried to the island by wind. No blue-green algae have been reported from Volcano Island, and perhaps on this account ferns have not been prominent. There are 21 species of *Pteridophyta* on the island, but these are mostly confined to deep ravines and to the sides of cliffs along the shore. They appear to be restricted largely to a substratum, which existed previous to the eruption of 1911; whereas on Krakatau the ferns were growing in new soil.

There are now 292 species of ferns and seed plants growing on Volcano Island. We call attention elsewhere to the fact that only a few of these have found a favorable habitat of any considerable extent as only 13 species are common and widely

[24] Treub, M., Notice sur la nouvelle Flore de Krakatau, *Ann. Jard. Bot. Buitenzorg* 7 (1888) 213.

distributed. In view of the fact that such a small proportion of the species that have invaded Volcano Island have become common and wide spread, it is not surprising that no phanerogams became prominent on Krakatau during the first three years after the eruption, when we consider the fact that Krakatau is much farther from the mainland than Volcano Island and so was invaded by a much smaller number of species.

In 1887, or fourteen years after the eruption of Krakatau, the island was visited by Penzig,[25] who found that the vegetation of the inland consisted of a kind of grass-steppe in which the grasses sometimes reached the height of a man and in several places formed a thick jungle. Trees were very scarce. Small grasses, ferns, and a few seed plants grow on the hills and ridges. The vegetation of the rock surfaces consisted largely of ferns and showed little change from the conditions observed by Treub in 1886.

The prominence of grasses and scarcity of trees is similar to the condition observed on Volcano Island. Grasses were much slower in becoming prominent on Krakatau than on Volcano Island; but it may be that they would have been much more prominent on Krakatau in the early stages, if their seeds had been transported to that island.

The essential differences between the revegetation of Volcano Island and Krakatau seem to be connected with the fact that Krakatau is situated in salt water and, therefore, has developed a strand formation which is lacking on Taal; while Taal being much nearer a large land mass has been invaded by many more species than Krakatau. These points will be considered later.

ENVIRONMENTAL CONDITIONS

The slowness of the revegetation of Volcano Island is probably not due, to any great extent, to the aêrial environment, as the surrounding country supports a luxuriant vegetation and the indications are that it was originally covered by a tall dipterocarp forest. The unfavorable factors are apparently connected with the condition of the substratum. The most evident of these are erosion and lack of weathering of the soil particles. Most of the steeper slopes are composed of soft loose material which is very readily eroded. An extreme case of erosion is seen in *Plate XVI, fig. 2,* which shows the outer slopes of the

[25] Penzig, O., Die Forstschritte der Flora des Krakatau, *Ann. Jard. Bot. Buitenzorg* II 3 (1902) 92–113.

southwestern rim of the main crater. It will be seen that there is a considerable tendency to form deep, narrow cañons with perpendicular walls. *Plate XVI, fig. 1,* represents such a cañon on the southern side of Volcano Island. The depth of this cañon can be calculated from the size of the men in the picture. Such cañons occur on all sides of the volcano. On the upper slopes where these cañons originate, the surface consists of small rounded mounds separated by shallow depressions; the latter unite, resulting in the formation of ravines which enlarge rapidly. As these cañons reach the lower and more gradual slopes they widen and coalesce to form the large deltal fans previously discussed. The method of erosion, just described, has a very great retarding effect on the vegetation.

The volcanic materials of which the upper layers of the soil of Volcano Island are composed have apparently not been weathered into a good soil. The surface is so loose that when one walks across it the feet sink in it to a depth of several millimeters. Equally striking is the comoposition of the soil, which in many places is composed largely of fine pebbly material. In Table II are given the percentages of soil particles in the different

TABLE II.—*Analysis of soils from Volcano Island.*

[Numbers give percentages based on total dry weights.]

Source of sample.	Depth of sample.	Total humus.	Total nitrogen.	Particles not passing 1-mm sieve.	Sulphuric anhydride (SO_3).			Acidity in terms of $CaCO_3$.
					Total.	Soluble in cold water.[a]		
						After standing 12 hours.	After shaking 3 hours.	
	cm.							
Crater rim	0–10	0.35	0.02	46.50	13.29	3.10	7.20	.....
Grass area	0–10	0.98	0.05	28.58	5.00	1.28	1.96	.....
Tree-covered area	0–10	1.38	0.13	38.40	1.97	0.15	0.61	.....
Crater slopes	5–25	0.37	0.01	45.00	12.56	1.82	5.22	0.155
Grass area	7–25	0.38	0.02	3.76	4.42	0.09	0.80	0.022

[a] Soil particles not crushed; determinations were made on particles passing through a 1-mm sieve.

samples that did not pass through a 1-millimeter sieve. The surface soil at the crater rim showed 46.5 per cent of such material. Preliminary examinations indicate that the water-holding capacity of the soil is low.

The chemical properties of the soil have probably also had

an important effect on the revegetation. Cox [26] gives an analysis of ash thrown out by the eruption of 1911. This analysis shows nearly 5 per cent of material readily soluble in water, including 0.3 per cent sulphuric anhydride (SO_3) and 0.74 per cent chlorine. This would indicate that such ash would not form soil favorable for plants until after the water-soluble material had been leached out to a very considerable extent.

Shortly after the eruption the surface of the crater lake was very much lower than at present and had streams of water flowing into it. Cox gives an analysis of the water of one of these

TABLE III.—*Analyses of water of Taal Crater, Lake Bombon, and spring at Ambulong.*

[Numbers give parts per million.]

Source.	Spring at Ambulong at northeast corner of Lake Bombon (1917).[a]	Lake Bombon (1917).		Crater Lake (1917).[b]	Hot stream flowing into Crater Lake in (1911).[c]
		Near Ambulong.[a]	Near Volcano Island.[b]		
Total solids by evaporation	370.0	1,220.0	1,540.0	40,000.0	----------
Specific gravity at 15° C	----------	----------	----------	1.02	----------
Acidity	4.6	----------	----------	0.0147 *N*	0.0069 *N*
Silica (SiO_2)	72.0	18.0	10.0	410.0	710.8
Iron and aluminum oxides $Fe_2O_3+Al_2O_3$	2.0	2.8	2.0	360.0	----------
Iron (Fe), total	1.4	0.24	0.14	135.0	172.0
Manganese	----------	----------	----------	310.0	79.9
Aluminum (Al)	trace	1.3	.95	86.0	26.1
Calcium (Ca)	41.0	59.0	64.0	860.0	556.8
Magnesium (Mg)	120.0	400.0	50.0	2,650.0	909.3
Sodium (Na)	----------	----------	----------	9,870.0	2,584.3
Potassium (K)	----------	----------	----------	870.0	237.4
Chlorides (Cl)	6.1	410.0	580.0	18,300.00	6,024.3
Bromides (Br)	----------	----------	----------	trace	----------
Iodides (I)	----------	----------	----------	0.49	----------
Sulphates (SO_4)	23.0	160.0	194.0	3,300.0	2,732.0
Phosphates (PO_4)	----------	----------	----------	18.0	----------
Normal carbonates (as CO_3)	0.0	12.3	24.0	----------	----------
Bicarbonates	300.0	190.0	150.0	----------	----------

[a] Analyzed by J. Gonzales-Nuñez, Bureau of Science, Manila.
[b] Heise, G. W., The crater lake of Taal Volcano, Philip. Journ. Sci. A 12 (1917).
[c] Cox, A. J., Philip. Journ. Sci. A 6 (1911) 96.

streams. This analysis is copied in Table III. The water contained 1.4 per cent of dissolved material, including over 0.6 per cent of chlorine, 0.26 per cent of sodium, and 0.27 per cent of the sulphate radicle (SO_4). The soil from which this high-

[26] Cox, A. J., The composition of the fine ejecta and a few other inorganic factors of Taal Volcano, *Philip. Journ. Sci. A* 6 (1911) 93–97.

mineral content was derived would certainly not be favorable for plant growth.

In order to determine something of the chemical character of the soil at the present time, we collected samples from the surface soil to a depth of 10 centimeters at the crater rim, in the grass area at the north end of the island, and in a tree-covered area on the northern slope of Mount Pirapiraso. A partial analysis of these soils was made for us by Mr. A. S. Argüelles, of the Bureau of Science. The results are given in Table II. None of the soils contained appreciable amounts of chlorine. Those from the crater rim and the grass area showed very excessive quantities of soluble sulphates. The humus and nitrogen content of the soil at the crater rim is extremely low; that of the grass area is much too low for a good soil; while even that of the tree-covered area is considerably lower than the average for Philippine soils.

The above-mentioned soil samples from the grass and the tree-covered areas contained plant roots. In the same grass area another sample of soil was taken under the roots at a depth of from 7 to 25 centimeters. The humus and nitrogen content was considerably lower than that for the surface layers, while the soluble sulphate content was very much lower. Another sample, taken on the upper slopes of the crater at a depth of from 5 to 25 centimeters, showed about the same percentage of humus as the surface sample, while the nitrogen content was even less.

Determinations of soil acidity (Table II) were made on samples of soil from the crater slopes and from the grass-covered area at the northern end of the island. In each case the acidity is very high, while that of the soil on the slopes of the crater is so extreme (0.155 per cent) that we would expect it to be very harmful to the vast majority of plants.

The chemical analysis just discussed certainly indicates that the soil of most of Volcano Island would form a very poor substratum for the growth of plants.

There is considerable evidence to show that water-soluble materials have been taken from the soil of Volcano Island at a fairly rapid rate. The land near the northwestern part of Bombon Lake near Ambulong is composed of nearly horizontal beds of water-laid volcanic tuff [27] through which there is a great seepage of water. An analysis of a sample of water taken from a large spring in the volcanic tuff at Ambulong (Table III)

[27] Pratt, W. E., Philippine lakes, *Philip. Journ. Sci. A* 11 (1916) 223–237, *pl. I.*

shows that this water does not contain an unusual amount of dissolved material; it has a total solid content obtained by evaporation amounting to 370 parts per million. The water of the lake contains a very much higher percentage of dissolved material as will be seen from the analysis in Table III. Near Ambulong the total solids amount to 1,220 parts per million and near Volcano Island to 1,540 parts per million. The large amount of dissolved material in Lake Bombon is probably derived from volcanic ejecta, and a considerable proportion of it may have come from Volcano Island.

The analysis (Table III) by Cox,[28] of water flowing into the crater lake in 1911 shows an unusual high content of dissolved mineral matter. A comparison of this analysis with the water in the crater lake in 1917 shows that the lake contains a much higher percentage of dissolved material than the water of the stream flowing into it in 1911. The amount of chlorides is about three times as great, while sodium shows an even greater increase in concentration. Calcium sulphate forms layers of considerable extent over the soil at the edge of the lake.

The amount of solid material in the water of the lake is very high, there being 40,000 parts per million. This high solid content shows that a great deal of soluble material has been taken out of the soil of Volcano Island, as the crater lake is of considerable size and depth. Pratt[29] says of this lake that after the eruption of 1911, the crater was occupied by a single lake about 1 kilometer in diameter, the surface of which was 70 meters below sea level when the first descent was made to it. Later it rose until, at the time at which he wrote, it stood at about sea level.

Another factor that will probably have considerable influence on the development of the vegetation is grass fires. In October, 1916, and January, 1917, there was no evidence of any considerable burnt areas on Volcano Island. By the first of April, 1917, fires had swept over a large portion of the north end of the island, including considerably more than half of Mount Bintiang Malaqui, much of Mount Tibag, the northern and eastern slopes of Mount Mataas-na-golod, and the northern slopes of Mount Ragatan. All these fires had occurred during the early part of the dry season; so that it may very well be that before the end of the season nearly all of the areas, in which the grass is thick enough for fire to spread from clump to clump, will have

[28] Cox, A. J., *Philip. Journ. Sci. A* 6 (1911) 96.
[29] Pratt, W. E., loc. cit.

been burned. The fires had apparently not killed any of the clumps of *Saccharum spontaneum* as, except in the most recently burnt areas, the clumps were producing new leaves. However, many trees, particularly the smaller ones, had been killed. Owing to this fact, it seems not improbable that trees may have been somewhat more numerous before fires of any considerable extent occurred on the island, than at the present time. Such trees could hardly have formed closed stands, as such stands kill the grass and fires do not burn through them. If fires continue to be prevalent on the island, it is probable that the grass areas at the northern end of the island will persist instead of being invaded by trees.

Soils derived from volcanic activity are usually very fertile, but the value of recent volcanic ejecta as a substratum for plants varies greatly. In some cases volcanic ash appears to produce a rich soil almost immediately. A conspicuous example of this is found in the region around the settlement of Kodiak, Alaska, which was covered nearly a foot deep with ash by the eruption of Mount Katmai in June, 1912.[30] The effect of the ash as described by Griggs is as follows:

> The most important settlement in the devastated district is Kodiak, which, although a hundred miles from the volcano, was buried nearly a foot deep in ash. This ashy blanket transformed the "Green Kodiak" of other days into a gray desert of sand, whose redemption and revegetation seemed utterly hopeless. When I first visited it, a year later, it presented an appearance barren and desolate. It seemed to every one there that it must be many years before it could recover its original condition.
>
> What, then, was my surprise on returning after an interval of only two years to find the ash-laden hillsides covered with verdure. Despite the reports I had received, I could not believe my eyes. Where before had been barren ash was now rich grass as high as one's head.
>
> Every one agrees that the eruption was "the best thing that ever happened to Kodiak." In the words of our hotel keeper, "Never was any such grass known before, so high or so early. No one ever believed the country could grow so many berries, nor so large, before the ash."

The above description certainly indicates that the ash thrown out by the eruption of Mount Katmai produced a very different substratum from that formed by the eruption of Taal Volcano.

The effect, on the growth of plants, of the ash thrown out by the eruption of the Soufrière in St. Vincent in 1902 was very different from the case just described and more like that of Taal.

[30] Griggs, R. F., The valley of ten thousand smokes, *National Geographic Magazine* 31 (1917) 13.

This eruption [31] devastated an extensive area of fertile, cultivated land. The depths of the covering of ejecta varied greatly in different places; [32] in some of the valleys it was from 50 to 80 feet thick; on fairly level land from 1 to 5 feet; and on steep slopes only a few inches deep. Experiments conducted in 1903 [33] with the ash showed that this was incapable of supporting plants but that if soil was mixed with the ash, fair crops of estate produce could be successfully grown.

The course of revegetation varied in different localities. In 1907 Anderson [34] found that the surface of ash near the Richmond works was not consolidated but was rapidly breaking up under the influence of plant roots, and humus was being formed. At the foot of the seaward slope of Richmond ridge there was a fan or plateau which was originally covered several feet thick with an incandescent avalanche. The surface of this consolidated into a crust nearly an inch thick. In 1907 Anderson found that no plants sprang up where this crust was perfect, but that where it was broken, as along the small water courses, a few plants were found.

The progress of revegetation in the above areas was described by Sands [35] in 1912 as follows:

> Starting from the ruined Richmond plantation works, it is seen that the ejecta, mixed to some extent with old soil brought down by rains from the higher lands above, are from 2 to 6 feet thick, and are being rapidly converted into soil under the influence of favorable climate conditions, the action of the roots of various plants and decaying organic matter * * *. With the exception of the Roseau grass [*Gynerium saccharoides* HBK.], the roots of which had not been killed, all the plants have gradually established themselves from seed brought by various agencies from lands near by * * *.
>
> From Richmond works, proceeding along the coast in the direction of the volcano, a plateau of ash is soon reached which was put down in the form of an incandescent avalanche. This avalanche destroyed Richmond village, and covered the northwest portion of the plantation lands to a depth of

[31] Anderson, T. and Flett, J. S., Report on the Eruption of the Soufrière in St. Vincent in 1902, and on a Visit to Montagne Pelèe, in Martinique.—Part I, *Phil. Trans. Roy. Soc. London* Sec. A. 200 (1903) 353–553.

[32] Sands, W. N., An account of the return of vegetation and the revival of agriculture, in the area devastated by the Soufrière of St. Vincent in 1902–3, *West Indian Bull.* 12 (1912) 22–31.

[33] Sands, W. N., loc. cit.

[34] Anderson, T., Report on the Eruption of the Soufrière, in St. Vincent, in 1902, and on a Visit to Montagne Pelèe, in Martinique.—Part II, *Phil. Trans. Roy. Soc. London* Sec. A. 200 (1908) 275–303.

[35] Sands, W. N., *West Indian Bull.* 12 (1912) 22–31.

several feet. It is observed that the top layer of ash has formed a crust, but this has been broken up at frequent intervals by heavy rains; the result is that numerous shallow water-channels have been formed. It is observed that it is only in these depressions that plants have been able to get a root-hold. The chief plant lining the sides is the silver fern (*Gymnogramme calomelanos*, Kaulf.) [=*Ceropteris calomelanos* Und.], which is playing the important part of preparing the ash for higher types. Already a few hardy plants such as the hurricane grass (*Arundinella martinicensis*, Trin.), *Emilia sonchifolia*, DC., cattle-tongue (*Pluchea odorata*, Cass.), *Eupatorium odoratum*, L., and a sedge or two are found growing with the ferns. Here it is evident that these are the true ash plants, and have grown from spores and fruits brought by wind and water; but chiefly by the former.

Areas, in which the destruction of the vegetation was not complete or where the ash has subsequently been largely washed away, have become covered with plants.

On the upper slopes of the volcano revegetation has been slow as will be seen from the following statement by Sands:

> At 1,400 feet, plants are scantily distributed and the growth is poor. Only the hardy bamboo and Roseau grasses, silver ferns and tree-ferns, *Freziera hirsuta*, Sw., and *Eupatorium odoratum*, L., appear to thrive. Here, however, is found the pretty moss *Lycopodium cernuum*, L., and the somewhat rare *Eupatorium ossaeanum*, DC. At 2,000 feet, silver ferns and mosses only are seen. From this altitude to the lower lip of the crater, which aneroid barometer readings indicate to be 2,800 feet above sea level, the ejecta assume a coarse, cindery form, in which at present only algae, mosses, and lichens are able to exist.

According to Anderson,[36] the early stages of the revegetation of Mount Pelèe were similar to those of the Soufrière.

In view of the fact that both the chemical and the mechanical compositions of volcanic ejecta vary greatly, it is not surprising that the effect on plants should be different in different cases. Probably the most usual condition is for recent ejecta to form a poor substratum for plants. This is particularly true of lava flows, which have to be weathered very considerably before they can support higher plants. Very interesting examples of this phenominon have been described from the Hawaiian Islands by Rock.[37]

Even when the ejecta form a soil composed of fairly small particles, such a soil is very frequently a poor substratum for plants until a considerable period has elapsed, when the soil has apparently been weathered and leached.

[36] Anderson, T., *Phil. Trans. Roy. Soc. London* Sec. A. 200 (1908) 275–303.
[37] Rock, J. F., The indigenous trees of the Hawaiian Islands. Honolulu (1913).

It is a common observation that the upper slopes of active volcanoes are usually very bare, and this is frequently the case even when there have been no recent eruptions.

Schimper [38] visited the volcano of Gunong Guntur in western Java many years after the vegetation had been completely destroyed by an eruption and found the vegetation quite open and very poor.

> There are absolutely no trees, but shrubby and herbaceous plants of very various species were present. * * *. The most essential part was played by plants that grew as epiphytes in the neighboring woods, namely many orchids, as well as several ferns and the shrubby *Rhododendron javanicum*, * * *.

The picture that Schimper gives of this vegetation indicates that the ground was very largely bare and that, as on the larger part of Volcano Island, the plants were very scattered.

Another interesting example of a sparse vegetation on a volcanic cone is afforded by the Gedeh in western Java. The active crater is a small cone within a much larger ancient crater. The slopes of the mountain and most of the ancient crater are covered by a dense and varied vegetation, while the slopes of the new cone, although signs of volcanic activity are very slight, show a very sparse vegetation. This mountain was visited by Brown and Yates in 1917. On the active cone there were present only the following 9 species of higher plants and ferns:

Gaultheria nummularioides G. Don.
Gaultheria leucocarpa Bl.
Gaultheria fragrantissima Wall.
Rhododendron retusum Benn.
Vaccinium varingiifolium (Bl.) Miq.
Anaphalis javanica Sch.
Carex hypsophila Miq.
Histiopteris incisa J. Sm.
Polypodium feeii Bory.

These include 5 *Ericaceae*, 1 composite, 1 sedge, and 2 xerophytic ferns. These plants were very scattered and all were small, there being no specimen on the active cone that was more than 0.5 meter in height. The density of the vegetation was very similar to that shown in Schimper's photograph taken on Gunong Guntur.

It seems evident that the invasion of soils of recent volcanic origin varies very greatly in different cases, and our present knowledge does not appear to justify us in trying to establish any general laws.

[38] Schimper, A. F. W., Plant-Geography upon a Physiological Basis. Eng. trans. by W. R. Fisher. Clarendon Press, Oxford (1903).

DISTRIBUTION OF SPECIES

For convenience of reference we have brought together in Table IV data on the relative abundance, the method of distribution, and the geographic origin and distribution of all the species that have been found on Volcano Island since the eruption in 1911.

The relative abundance of the individual species is merely approximate, as no exact counts were taken. Under "very rare" are listed those species observed only in one or two localities, and represented by a single or very few specimens; "rare or local" indicates those species which, while more abundant than the above, are not conspicuous and are usually confined to a limited area; "fairly common" includes those of general distribution that are not dominant; by "very common" are indicated the comparatively few species that are widely distributed and dominant.

In listing the methods of distribution of seeds we have considered only those means by which they are carried to a considerable distance and have left out of account those devices, such as explosive pods which can distribute the seeds only a few meters. Very few actual experiments have been performed to determine the possible methods of distribution so that we have relied on inferences drawn from the character of the fruits, supplemented, in many cases, by direct observation. While the data cannot threfore be regarded as exact, they should be sufficiently accurate to allow general conclusions to be drawn from them.

Under the heading "eaten by birds" are placed most of the species with fleshy fruits as well as some species with dry fruits that are known to be distributed by birds.

The heading "wind" includes those seeds with definite wings, pappus, or other appendages adapted to aërial dispersal; also the minute, dust-like seeds of the *Orchidaceae* and the spores of ferns.

Under "water" are placed those species that have manifest adaptations for dispersal by means of floating seeds or fruits. Some species whose fruits are not specially suited for this method of dissemination have reached Volcano Island by floating as the distance from the shore of the mainland to the island is not great. Viable seeds of *Samanea saman*, *Cucurbita maxima*, and *Citrullus vulgaris* were found in the drift on the beach. Even more conspicuous was a large fleshy fruit of *Artocarpus integrifolia* with the fruit as well as the seeds in perfect condition. None of

the above plants appear to be specially adapted for dispersal by floating. Owing to the short distance from the mainland it is probable that many other seeds having no special adaptation for floating have reached the island by this means. Some, which by themselves cannot float at all, may have been carried by floating drift. This is particularly true, since in a short time the fresh water would not impair the germinating power of the seeds. It is a well-known fact that most of the seeds of tropical weeds will not float and this is apparently true of most species with minute seeds. This fact, however, does not preclude the possibility that some of these plants may have been transported by the last-mentioned method.

The heading "organs for adhering" includes those seeds and fruits with hooks and spines, barbed or viscid hairs, or other special adaptation by which they adhere to the fur of animals, the clothing of man, or the feathers of birds. *Hyptis suaveolens*, a most successful weed, falls in this group on account of the gelatinous viscid covering of the wet seeds.

Under the heading "eaten by animals" are placed those plants eaten by cattle and which may be disseminated by such seeds as are not digested. Most of these seeds are minute and very hard. It is probable that some species have thus reached Volcano Island, and it is certain that a number of them have been disseminated over the island by this means as a considerable number of cattle, carabaos, and horses range on the island.

Under the heading "man" are included those species that are usually disseminated only or chiefly by man. *Annona reticulata*, custard apple; *Arachis hypogaea*, peanut; *Bambusa* spp., cultivated bamboos; *Ipomoea batatas*, sweet potato; *Oryza sativa*, rice; *Manihot utilissima*, cassava; *Musa* sp., banana; and a few others are found on the island.

Under "minute seeds" we have placed a large number of species—characteristic fresh-water plants, rice-paddy weeds, and others—which are for the most part of very wide geographic distribution; but whose seeds usually do not float, are not adapted for dissemination by the wind, and yet are most successful emigrants. Many, if not most, of these are distributed through the medium of mud, in which the seeds are imbedded in large numbers, adhering to the feet and coats of birds and other animals.

There are a number of species—some of them are very wide distribution and abundant in all tropical countries—that we have not succeeded in classifying according to the method by which

their seeds are distributed, as we have not observed any evident means of dissemination.

Under geographic origin and distribution we have indicated species of American origin; species of Asiatic origin; the endemic species; those distributed in all or some parts of the Indo-Malayan region in addition to the Philippines; and those of pantropic distribution, including the species naturally occuring in both hemispheres and the ones that have been purposely or accidentally transmitted by man from one hemisphere to the other. In some cases it has been impossible to determine the origin of species of pantropic distribution.

In the enumeration in Table IV of the plants found on Volcano Island, we have included only the vascular crytogams and the phanerogams. The cellular cryptogams are for the most part conspicuous by their absence. Along the coast a few of the rocks subject to the wash of the waves are densely covered by a species of *Cladophora*, but on the bare soil of the island there is no indication of an algal growth such as Treub [39] found on Krakatau, from which he assumed that the *Cyanophyceae*, diatoms, and other algae prepared the soil for the reception of seeds and spores of higher plants. The only lichen observed was a single species, apparently *Bilimbia artytoides* (Nyl.), on the walls of a few cañons, this being locally abundant; no lichens were observed on the bark or the leaves of trees, although a careful search was made for such forms. The *Hepaticae* are represented by *Anthoceros spongiosus* Steph. and an undetermined form; the *Musci* by *Trematodon acutus* C. Müll. and two or three other, undetermined species. The mosses and hepatics, however, are confined to the damp ravines and the damp soil of bluffs near the shore, and are abundant only in very limited areas.

A considerable number of the species mentioned in Table IV were represented by a single plant, and nearly every one of the deeper ravines in the northern part of the island contained at least one species not observed elsewhere. It is, therefore, unreasonable to suppose that every species growing on the island has been detected; but it is practically certain that the list does include all species that are either abundant or prominent, and the number of species not included is probably small.

In Table IV the species found by Gates, but not observed by us in 1916–17, thirteen in number, are indicated by a dagger while those observed in 1916–17, but not found by Gates, are

[39] Treub, M., Ann. Jard. Bot. Buitenzorg 7 (1887) 213.

indicated by an asterisk. The species observed by Gates, but not found by us are:

Antidesma rostratum.
Aerua lanata.
Citrullus vulgaris.
Ficus nervosa.
Gymnema tingens.
Ipomoea batatas.
Crataeva religiosa.
Cyperus radiatus.
Elaeagnus philippensis.
Lemna trisulca.
Muntingia calabura.
Oryza sativa.
Phaleria cumingii.

Of these species *Oryza sativa, Citrullus vulgaris,* and *Ipomoea batatas* are cultivated forms dependent on man for their persistence, and they may no longer occur on Volcano Island, as the plants observed by Gates were probably merely adventive ones. *Lemna trisulca* was represented only by plants thrown up on the shore; while *Cyperus radiatus,* a marsh plant, which was local along the shore, probably occurred in a very unstable habitat. The remaining eight species, mostly conspicuous ones, must now be rare or at least very local on the island, otherwise they would in all probability have been detected in 1916–17.

It has been necessary to make a few alterations in Gates's list, on account of changes in nomenclature. In some cases he was not able to collect material suitable for identification, and a comparison of his specimens with the collections of 1916–17 has necessitated a few corrections. *Atalantia disticha* and *Sida cordifolia,* enumerated by Gates, are not included in Table IV, as the only specimens of these plants collected by him were from a neighboring island. Gates's list, with the changes indicated above, includes 175 species.

In Table IV are listed 117 additional species, nearly all of which must have invaded the island between April, 1914, and January, 1917. It is, of course, probable that Gates overlooked a few species growing on the island at the time of his visit, and this is apparently true of *Bambusa vulgaris, Arytera littoralis,* and *Erioglossum rubiginosum.* The last two are arborescent species and are now represented by mature specimens. However, the number of species that Gates overlooked must be very small.

The total number of species in Table IV is 292. Among these are included nearly two-thirds of the 236 species listed by Centeno as having been collected on the island between 1877 and 1879. Centeno's list was evidently very incomplete, and it is probable that it contains in general the plants that were the most common and conspicuous on the island. The high percentage of species in this list which have been collected on the

island since the eruption in 1911 indicates that about two-thirds of the species which were common before the eruption occur on the island at the present time.

The invasion of Volcano Island by new species has evidently taken place at a very rapid rate. However, only thirteen species are listed in Table IV as common and widely distributed. This indicates that few of the species have found favorable habitats of considerable extent and affords additional evidence that the slowness of revegetation is due to adverse environmental conditions rather than to a lack of seeding.

A large proportion of the species are widely distributed in the tropics. Ninety-six, or 33 per cent, are of pantropic distribution; while an additional one hundred fifty, or 51 per cent, are found in other parts of the Indo-Malayan region as well as in the Philippines. Only forty-six, or 16 per cent, are confined to the Philippine archipelago. Most of the species on Volcano Island are common and widely distributed in inhabited areas at low altitudes in the Philippines. Merrill [40] has shown that in such regions the percentage of endemic species is small, being only about 12 per cent. In his calculations cultivated as well as spontaneous species are considered. The percentage of endemism among spontaneous species would be somewhat greater.

The preponderance of widely distributed plants in the cultivated areas in the Philippines is similar to the condition prevailing in many tropical countries. The wide distribution of these species is due to the fact that many tropical countries originally supported tall dense forests, the removal of which, produced conditions suitable for plants more xerophytic than most of those previously occurring in the region. The artificial production of similar habitats in many parts of the tropics has made it possible for plants suitable for those habitats to become widely distributed, largely through the agency of man, either purposely or accidentally.

Most of the species on Krakatau are also of wide distribution. In speaking of those in the interior of the island Ernst [41] says:

Within their respective distribution-areas they belong to the commonest plants and to such as grow indifferently in a great variety of habitats. These constituents of the new Krakatau flora owe their occurence in the new habitat, as also their wide distribution, chiefly to the efficient adaptation of their fruits and seeds to distant transport.

[40] Merrill, E. D., Notes on the Flora of Manila with special reference to the introduced element, *Philip. Journ. Sci.* 7 (1912) *Bot.* 145–208.

[41] Ernst, A., The New Flora of the Volcanic Island of Krakatau (1908) 48.

This statement is certainly applicable to most of the plants on Volcano Island. The percentage of species common to the two islands is, however, small. Ernst gives a list of forty-one species occurring in the interior and not on the strand. Only eleven of these are found on Volcano Island, although twenty-four occur in the Philippines. The plants found on Krakatau indicate a climate distinctly more moist than that of Taal.

The species occurring on the strand of Krakatau would naturally be different from those on Volcano Island. Ernst mentions sixty-seven species on the strand of Krakatau. Of these eleven are found on Volcano Island, while fifty-five are known from the Philippines.

From the data given in Table IV we have calculated the approximate percentage of plants distributed by different means. For reasons which have already been explained, the calculations cannot be made exact.

Birds would appear to be the most important agency of dispersal. Eighty-three, or 28 per cent, are listed as being eaten by birds; fourteen, or 5 per cent, have organs for adhering and so may be carried by birds; while sixty, or 21 per cent, are characterized by minute seeds which could be distributed in mud on the feet or the feathers of birds. There are thus one hundred fifty-seven species, or 54 per cent, of the total on the island which could have been carried to it by birds.

Sixty, or 21 per cent, are apparently distributed by wind; while only twenty-six, or 9 per cent, are adapted to dispersal by water.

Thirty-nine, or 13 per cent, can be scattered by being eaten by animals. As a considerable number of cattle and carabao have been taken to the island since the eruption, a number of the above plants may have reached the island or have been subsequently distributed over it by this means. Many of the plants in this category are also included among those that could be disseminated by birds or wind.

Twenty-one species, or 7 per cent, are normally distributed by man. At least three of these, *Bambusa blumeana, B. vulgaris,* and *Musa sapientum,* are relics of former cultivation on the island. A few of the species may have been distributed by man since the eruption. Some of the species that are usually distributed by man are also distributed by birds and in our calculations are included under both headings. A few species, usually distributed by man, which are not particularly adapted for floating have evidently reached the island by the latter means.

Owing to the short distance between Volcano Island and the

mainland a number of different methods have been effective in carrying seeds to the island. More species seem to have been introduced by birds than by any other single agency. Birds have also been effective in scattering seeds on the island as, with a single exception, all of the commonest tree species are distributed by them. Next to birds, wind has brought the largest number of species to the island. When the predominance of grasses is considered it would seem that this agency is responsible for the presence of the bulk of vegetation on the island.

The relative effectiveness of the various methods of dispersal has been quite different in the case of Krakatau.[42] Owing to the greater distance of Krakatau from the mainland the invasion by different species has been slower than on Volcano Island. Twenty-three years after the destruction of the vegetation of Krakatau this island was visited by Ernst who gives a list of the species that had been collected on it up to that time. This list includes ninety-two seed plants and sixteen *Pteridophyta*. Ocean currents had been the most important method by which phanerograms had reached the island. According to Ernst 39 per cent had certainly been carried to the island by this means, while the number that might have been introduced by sea currents amounted to 72 per cent of the total. The number of seed plants that almost certainly had been transported by wind amounted to 16 per cent, while the addition of those that might possibly have been carried by this method would bring the total to 32 per cent. Birds were apparently much less effective than the two agencies just mentioned. Ernst says that 10 per cent of the total were certainly introduced by this method while an additional 9 per cent may, possibly, have been so transmitted.

A comparison of the invasion of Krakatau and Volcano Island shows a very apparent difference in the efficiency of dispersal by birds over long and short distances. Not only is the number of species distributed by this means much greater in the case of Volcano Island, but the percentage is also greater. This is in harmony with the observation of Kerner [43] that the interval between eating and ejecting of food is in the case of most birds, from one and a half to three hours. Wind has carried many more species to Volcano Island than to Krakatau. This is, of course, due to the greater distance in the latter case. The percentage of species introduced on Krakatau during the first four-

[42] Ernst, A., op. cit.

[43] Kerner, A., The Natural History of Plants. Translated by F. W. Oliver, 2: 864.

teen years after the eruption and which were carried by wind was, however, greater than has been the case on Volcano Island.

The difference in the effectiveness of water in transporting seeds cannot be accurately compared in the case of Volcano Island and Krakatau as the former is situated in fresh and the latter in salt water.

TABLE IV.—*Distribution and methods of distribution of plants found on Volcano Island since the eruption of Taal Volcano in 1911.*

[The * indicates additions to Gates's 1914 list; the † indicates species of Gates's that were not observed on Volcano Island in 1916–1917.]

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
Abrus precatorious		×			(?)								×			×
Acacia farnesiana				×					(?)			×				×
*Acrostichum aureum**		×				×										×
*Adiantum caudatum**		×				×							×		×	
Adiantum philippense		×				×										×
Aerua lanata †		×									×		×		×	
*Aganosma acuminata**		×				×							×		×	
Ageratum conyzoides			×			×						×				×
Albizzia procera			×										×		×	
Allaeanthus luzonicus	×				×								×	×		
*Alstonia macrophylla**	×					×							×		×	
Alstonia scholaris		×				×							×		×	
Alternanthera sessilis		×									×					×
Alysicarpus vaginalis			×										×			×
Amaranthus spinosus			×								×					×
Amorphophallus campanulatus	×				×								×		×	
*Andropogon fragilis**	×							×	×				×		×	
*Aneilema malabaricum**	×										×		×		×	
*Anisomeles indica**		×									×		×		×	
*Annona reticulata**	×				×					×		×				×
Antidesma bunius			×		×								×		×	
Antidesma ghaesembilla				×	×								×		×	
Antidesma rostratum †	×				×								×	×		
Arachis hypogaea	×									×		×				×
Arenga saccharifera	×								(?)	×			×		×	
*Aristolochia tagala**		×				×							×		×	
Artocarpus lamellata	×				×								×	×		
*Arytera littoralis**	×				×								×		×	
Bambusa blumeana		×								×			×		×	
*Bambusa vulgaris**	×									×			×			×
*Blechnum orientale**			×			×							×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
*Blechum brownei**		×										×				×
Blumea balsamifera			×			×							×		×	
Blumea lacera			×			×							×		×	
*Blumea mollis**			×			×							×		×	
*Blumea glomerata**		×				×							×		×	
*Boehmeria blumei**			×								×		×		×	
*Bonnaya brachiata**			×						×		×		×		×	
Breynia acuminata		×			×								×	×		
Breynia cernua		×			×								×		×	
Breynia rhamnoides		×			×								×		×	
Bridelia stipularis			×		×								×		×	
*Bryonopsis laciniosa**		×			×								×		×	
Buddleia asiatica			×			×							×		×	
Bulbostylis barbata				×					×		×		×		×	
*Caesalpinia crista**		×					×						×			×
Callicarpa blancoi				×	×								×	×		
*Calotropis gigantea**		×				×							×		×	
*Calonyction album**		×										×				×
Canavalia ensiformis			×				(?)						×		×	
Canavalia lineata		×					×									×
Cantharospermum scarabaeoides			×						×				×		×	
Capparis horrida			×		×								×		×	
Capparis micracantha		×			×								×		×	
*Capsicum fruticosum**		×			×							×				×
Carica papaya		×			×							×				×
Casearia cinerea			×		×								×	×		
*Cassia alata**	×											×				×
*Cassia tora**	×								(?)			×				×
Cassytha filiformis		×					×									×
Ceiba pentandra		×				(?)				×		×				×
Celastrus paniculata			×		×								×		×	
*Centella asiatica**		×							×							×
Ceratophyllum demersum		×									×					×
*Ceropteris calomelanos**			×			×						×				×
*Cheilanthes tenuifolia**		×				×							×		×	
Cissampelos pareira		×			×											×
Cissus repens		×			×								×		×	
Citrullus vulgaris†	×									×			×			×
*Cnestis diffusa**		×			×								×	×		
Clerodendron minahassae			×		×								×		×	
*Clitoria ternatea**	×									×		×				×
Columella (Cissus) trifolia		×			×								×		×	
*Commelina benghalensis**	×										×		×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
Commelina nudiflora		×									×					×
*Corchorus acutangulus**	×										×		×		×	
Cordia myxa Linn			×		×								×		×	
Crataeva religiosa†	×				×								×		×	
Cratoxylon blancoi		×				×							×	×		
Crotalaria albida			×						(?)				×		×	
*Crotalaria acicularis**		×							(?)				×		×	
*Crotalaria stenophylla**		×							×				×		×	
*Crotalaria verrucosa**	×						(?)						×		×	
*Cyanotis cristata**		×									×		×		×	
*Cucurbita maxima**	×								×	×		×				×
Cynodon dactylon		×							×		×					×
Cyperus compressus		×							×		×					×
Cyperus diffusus		×							×		×		×		×	
Cyperus distans		×							×		×		×		×	
Cyperus radiatus†	×								×		×		×		×	
*Cyperus rotundus**		×							×		×					×
*Cyperus uncinatus**		×							×		×		×		×	
Dactylocteniem aegyptium		×							×		×		(?)			×
Datura alba		×					(?)						×		×	
Deeringia baccata		×			×								×		×	
Derris polyantha		×											×	×		
Desmodium gangeticum			×					×					×			×
*Desmodium procumbens**	×							×				×				×
Desmodium pulchellum			×					×					×		×	
Desmodium scorpiurus			×					×				×				×
Desmodium triflorum			×					×								×
Digitaria consanguinea		×							×		×		×		×	
*Digitaria ciliaris**		×							×		×					×
Dioscorea bulbifera	×					×							×		×	
Dioscorea luzonensis		×				×							×	×		
*Dioscorea myriantha**	×					×							×		×	
*Dioscorea triphylla**	×					×							×		×	
*Dioscorea aculeata**		×				×							×		×	
Dracontomelum cumingianum	×				×								×	×		
*Dryopteris parasitica**	×					×										×
Eclipta alba		×					×						×			×
*Eclipta zippeliana**	×						×						×		×	
Elaeagnus philippensis†	×				×								×	×		
Eleusine indica		×							×		×					×
Emilia sonchifolia		×				×							×			×
*Eragrostic amabilis**		×							×		×					×

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
*Eragrostis distans**		×							×		×		×	×		
Erigeron linifolius		×				×						×				×
*Erioglossum rubiginosum**	×				×									×	×	
Erythrina indica	×						×						×		×	
Eugenia jambolana				×	×					×			×			×
*Eulophia squalida**	×				×								×		×	
*Euphorbia hirta**		×									×					×
*Ficus concinna**	×				×								×	×		
Ficus cumingii			×		×								×	×		
Ficus hauili				×	×								×	×		
Ficus indica				×	×								×			×
Ficus nervosa†	×				×								×		×	
*Ficus nota**	×				×								×	×		
*Ficus odorata**	×				×								×	×		
*Ficus stipulosa**	×				×								×	×		
Ficus tinctoria		×			×								×		×	
Ficus ulmifolia			×		×								×	×		
*Fimbristylis merrillii**	×								×		×		×	×		
*Fimbristylis polytrichoides**			×						×		×		×		×	
*Fimbristylis squarrosa**		×							×		×					×
*Flacourtia rukam**	×				×								×		×	
Fluggea virosa			×		×								×		×	
*Gleichenia linearis**	×					×							×		×	
Gliricidia sepium			×							×		×			×	
*Glochidion rubrum**	×				×								×	×		
Glochidion triandrum		×			×								×	×		
*Gmelina philippensis**		×			×								×	×		
Gymnema pachyglossum		×				×							×	×		
Gymnema tingens†	×					×							×		×	
*Hedyotis tenelliflora**	×										×		×		×	
Heliotropium indicum		×									×		×			×
*Hemigraphis rapifera**	×												×		×	
*Hemionitis arifolia**		×				×							×		×	
*Hetaeria oblongifolia**	×					×							×		×	
*Hibiscus surattensis**	×												×		×	
Hewittia sublobata		×											×		×	
*Hygrophila angustifolia**	×						×						×		×	
*Hyptis suaveolens**	×							×				×				×
Imperata cylindrica var. *koenigii*			×			×							×		×	
Ipomoea batatas†	×									×		×				×
Ipomoea obscura		×											×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
Ipomoea pescaprae				×			×					×				×
*Ipomoea paniculata**		×					×					×				×
Ipomoea pestigridis		×											×		×	
*Ipomoea reptans**	×						×						×		×	
Ipomoea triloba		×										×				×
*Kyllinga monocephala**	×								×		×		×		×	
Jussiaea repens	×						×				×					×
*Jussiaea linifolia**	×										×	×				×
Lemna trisulca†	×						×				×					×
Leucas javanica		×											×		×	
Lindenbergia philippensis		×									×		×		×	
Litsea glutinosa			×		×								×		×	
Luffa cylindrica			×				×			×			×			×
*Lycopodium cernuum**	×					×										×
Lycopersicum esculentum	×				×					×		×				×
Lygodium japonicum		×				×							×		×	
*Lygodium scandens**		×				×							×		×	
Macaranga tanarius			×		×								×		×	
Maesa cumingii			×		×								×	×		
Maesa laxa Mez*		×			×								×	×		
*Malaisia scandens**	×				×								×		×	
Mallotus moluccanus			×		×								×		×	
Manihot utilissima	×									×		×				×
Mariscus stuppeus		×					(?)				×		×		×	
*Melothria mucronata**	×				×								×		×	
Mezoneurum latisiliquum		×					(?)						×		×	
*Microlepia speluncae**		×				×							×		×	
Miscanthus sinensis		×				×							×		×	
*Mitrosacme alsinoides**			×								×		×		×	
Momordica charantia		×			×								(?)			×
Momordica cochinchinensis		×			×								×	×		
Momordica ovata			×		×								×		×	
Morindu bracteata				×	×		(?)						×		×	
Moringa oleifera	×									×			×		×	
*Mucuna nigricans**	×						×						×		×	
Muntingia calabura†	×				×							×				×
Musa sapientum		×								×			×			×
*Mussaenda philippica**	×				×								×	×		
Nephrolepis biserrata			×			×										×
*Neonauclea bartlingii**	×					×							×	×		
*Notholaena densa**	×					×							×		×	
Odontosoria chinensis			×			×							×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
Oldenlandia corymbosa		×									×		×			×
Onychium siliquosum		×				×							×		×	
Operculina turpethum		×					(?)									×
Oplismenus compositus *		×						×	×				(?)			×
Oroxylum indicum		×				×							×		×	
Oryza sativa †	×									×			×			×
Otophora fruticosa *		×				×							×		×	
Ottelia alismoides *		×					×				×		×		×	
Pachyrrhizus erosus	×									×		×				×
Pandanus tectorius	×						×						×		×	
Panicum carinatum *		×							×		×		×	×		
Panicum caudiglume		×							×		×		×		×	
Panicum distachyum		×							×		×		×		×	
Panicum repens		×					(?)		×							×
Paspalum distichum		×					(?)		×							×
Paspalum scrobiculatum		×							×				×		×	
Pericampylus incanus		×			×								×		×	
Phaleria cumingii †	×				×								×	×		
Phaseolus adenanthus *			×				×									×
Phragmites vulgaris		×				×										×
Phyllantus erythrotrichus		×									×		×	×		
Physalis minima *		×			×							×				×
Pipturus arborescens			×		×								×		×	
Pistia stratiotes		×					×				×		×		×	
Pithecolobium dulce				×	×							×				×
Pogonatherum paniculatum *	×					×							×		×	
Polanisia viscosa	×										×					×
Pongamia pinnata		×					×						×		×	
Portulaca oleracea	×										×					×
Polygonum barbatum *	×						(?)						×		×	
Pouzolzia zeylanica *	×										×		×		×	
Premna nauseosa		×			×								×	×		
Premna odorata *		×			×								×	×		
Psidium guajava			×		×							×				×
Pteris vittata		×				×							×		×	
Pteris quadriaurita		×				×							×		×	
Pterocaulon cylindrostachyum		×				×							×		×	
Pueraria phaseoloides *			×						×				×		×	
Pycreus nitens *	×								×				×		×	
Pycreus holosericeus *	×								×				×		×	
Pycreus odoratus *			×						×							×
Pyxidaria crustacea		×									×		×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribucion.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
Pyxidaria pusilla			×							×			×		×	
Quisqualis indica		×											×		×	
Ricinus communis		×					(?)			×			×			×
*Rottboellia exaltata**	×								×				×		×	
Rourea erecta		×			×								×	×		
Saccharum spontaneum				×		×							×		×	
*Samanea saman**	×						×			×		×				×
Scoparia dulcis		×									×	×				×
Selaginella belangeri		×				×							×		×	
Semecarpus cuneiformis			×		×								×	×		
Sesbania cannabina	×						×						×		×	
Sida acuta		×						×								×
Sida rhombifolia		×						×								×
*Solanum cumingii**	×				×								×	×		
*Solanum nigrum**	×				×							×				×
*Solanum verbascifolium**		×			×											×
Spermacoce hispida		×									×		×		×	
*Sphaeranthus africanus**	×					×							×		×	
*Spirodela polyrrhiza**	×						×				×					×
*Stictocardia campanulata**	×						(?)						×		×	
Streblus asper		×			×								×		×	
*Stenochlaena palustris**	×					×							×		×	
Sterculia foetida		×					(?)						×		×	
Streptocaulon baumii			×			×							×	×		
Synedrella nodiflora		×						×				×				×
Tabernaemontana pandacaqui			×		×								×	×		
Tabernaemontana subglobosa				×	×								×	×		
Tephrosia dichotoma		×							×				×	×		
*Terminalia catappa**	×						×						×			×
Tetrastigma harmandii		×			×								×		×	
*Torenia peduncularis**	×										×		×		×	
Themeda gigantea			×			×							×		×	
*Torulinium ferax**	×						(?)				×					×
Tournefortia sarmentosa		×			×								×		×	
Trema orientalis				×	×								×		×	
*Trianthema monogyna**	×						(?)				×		×		×	
*Trichodesma zeylanicum**	×										×		×		×	
Triumfetta bartramia			×					×								×
*Tylophora perrottetiana**	×					×							×	×		
*Urena lobata**		×						×								×
Vallisneria gigantea		×					×				×		×		×	

TABLE IV.—*Distribution, etc.*—Continued.

Species.	Relative abundance.				Method of distribution.							Geographic origin and distribution.				
												Origin.		Distribution.		
	Very rare.	Rare or local.	Fairly common.	Very common and widely distributed.	Eaten by birds.	Wind.	Water.	Organs for adhering.	Eaten by animals.	Man.	Minute seeds.	American.	Asiatic.	Endemic.	Indo-Malaya.	Pantropic.
*Vernonia patula**	×					×							×		×	
Vernonia cinerea			×			×							×		×	
Vigna lutea		×					×									×
Vitex parviflora	×				×								×	×		
*Vitex trifolia**	×				×								×		×	
Waltheria americana			×									×	×			×
Wedelia biflora		×					×						×		×	
Wendlandia luzonensis	×					×							×	×		
Wrightia laniti			×			×							×	×		
*Zornia diphylla**		×						×	×			×				×
Totals	96	128	55	13	83	60+	26+	14	39+	21	60	37	211	46	150	96

ANNOTATED LIST OF THE SPECIES OF PTERIDOPHYTES AND SPERMATOPHYTES FOUND ON VOLCANO ISLAND SINCE THE ERUPTION OF TAAL VOLCANO IN 1911 [44]

POLYPODIACEAE

Acrostichum aureum Linn.* *Lagólo.* A few plants were observed on cliffs in sheltered ravines; none seen near the coast.

Adiantum caudatum Linn.* Widely scattered on bluffs near the shore.

Adiantum philippense Linn. *Culantrillo.* Scattered in shaded ravines.

Blechnum orientale Linn.* Abundant in some ravines at the northern end of the Island.

Ceropteris calomelanos (Linn.) Und.* Widely distributed on cliffs and in ravines, locally abundant; one plant was observed nearly at the crater rim, and a few within the crater near the base of the northeastern wall.

Cheilanthes tenuifolia (Burm. f.) Sw.* Widely scattered on earth banks and in ravines.

Dryopteris parasitica (Linn.) O. Kuntze.* Rare, a few juvenile plants in ravines.

Hemionitis arifolia (Burm. f.) Moore.* Widely scattered in ravines.

[44] In this list those species marked with an asterisk are additions to the list of Taal plants published by Gates in 1914; the dagger indicates those species recorded by Gates in 1914 that were not observed on Volcano Island in 1916–1917.

Microlepia speluncae (Linn.) Moore.* Widely scattered in ravines; not common.

Nephrolepis biserrata Schott. Widely distributed in ravines, open slopes, etc.; a single plant was observed just below the crater rim on the inside of the crater, and one at the base of the crater on the northeastern wall.

Notholaena densa J. Sm.* On bluffs near the beach and on walls of cañons; not abundant and very local.

Odontosoria chinensis (Linn.) J. Sm. Noted especially in ravines and cañons, locally abundant; a few plants in the crater on the northeastern wall.

Onychium siliquosum (Desv.) C. Chr. In ravines and cañons; local and not abundant.

Pteris vittata Linn. (*P. longifolia* Auct., non Linn.). On cliffs and walls of cañons; local.

Pteris quadriaurita Retz. In shaded ravines; local.

Stenochlaena palustris (Burm. f.) Bedd.* *Hagnáya.* A few plants observed back of the beach, in thickets, near Pirapiraso.

GLEICHENIACEAE

Gleichenia linearis (Burm. f.) Bedd.* A few juvenile plants observed in one ravine.

SCHIZAEACEAE

Lygodium japonicum (Thunb.) Sw. *Níto.* Widely scattered in thickets and in ravines; a few plants occur within the crater near the base of the northeastern wall.

Lygodium scandens (Linn.) Sw.* *Níto.* Not uncommon in thickets about Pirapiraso.

LYCOPODIACEAE

Lycopodium cernuum Linn.* A few juvenile plants observed on damp walls of a single cañon.

SELAGINELLACEAE

Selaginella belangeri Bory. On banks and among *Saccharum;* locally common.

PANDANACEAE

Pandanus tectorius Soland. *Pandán.* A few widely scattered individuals on open slopes; rare.

HYDROCHARITACEAE

Ottelia alismoides (Linn.) Pers.* *Calabáo.* Abundant along the northern coast, cast up by the waves.

Vallisneria gigantea Graebn. *Cíntas.* Apparently abundant in shallow water of coves and bays, as the plant is cast up on the beach in large quantities.

GRAMINEAE

Andropogon fragilis R. Br.* Rare.

Bambusa blumeana Schultes f. *Cauáyan totóo.* A number of tufts near Pirapiraso and a few in other localities, all from previous cultivation.

Bambusa vulgaris Schrad.* *Tianaúac.* A few tufts at Pirapiraso; all from previous cultivation.

Cynodon dactylon (Linn.) Pers. *Grama.* Widely scattered in damp soil near the beach.

Dactyloctenium aegyptium (Linn.) Richt. Widely scattered at low altitudes; not common.

Digitaria consanguinea Gaudich. Widely scattered at low altitudes at the northern end of the Island.

Digitaria ciliaris (Retz.) Pers.* With the preceding species, but less common.

Eleusine indica (Linn.) Gaertn. Scattered along the northern coast of the island.

Eragrostis amabilis (Linn.) W. & A. (*E. tenella* R. & S.).* Widely scattered along the beach.

Eragrostis distans Hack.* Not uncommon on dry banks of ravines at low altitudes.

Imperata cylindrica var. **koenigii** Benth. *Cógon.* Locally abundant, especially at the northern end of the island; in some places gregarious.

Miscanthus sinensis Anders. In widely scattered tufts; nowhere abundant or gregarious.

Oplismenus compositus (Linn.) Beauv.* Abundant in a few places at Pirapiraso.

Oryza sativa Linn.† *Bigás.* "One specimen seen." (Gates.) Not found in 1916–17.

Panicum carinatum Presl.* Abundant in ravines and thickets.

Panicum caudiglume Hack. At the base of bluffs along the coast and on the walls of cañons; locally abundant.

Panicum distachyum Linn. Widely scattered in damp soil at low altitudes.

Panicum repens Linn. In damp soil near the beach.

Paspalum distichum Linn. Gregarious in limited areas immediately back of the beach.

Paspalum scrobiculatum Linn. Widely scattered at low altitudes.

Phragmites vulgaris (Lam.) Trin. *Tambó.* Confined to very limited areas immediately on or back of the beach; nowhere abundant, and apparently rapidly being eliminated by other vegetation.

Pogonatherum paniculatum (Lam.) Hack.* On damp cañon walls; very local and not abundant.

Rottboellia exaltata Linn.* *Aguíngay.* A coarse annual grass of rare and local occurrence at low altitudes.

Saccharum spontaneum Linn. subsp. *indicum* Hack. *Talához.* Dominent nearly everywhere where vegetation occurs, except in the dense thickets and ravines where shrubs and small trees occur; on the upper slopes usually dwarfed and often from 20 to 30 cm. high. The only conspicuous plant within the crater, here widely scattered and usually dwarfed.

Themeda gigantea (Cav.) Hack. Locally abundant, in some places gregarious, and widely distributed on open slopes.

CYPERACEAE

Bulbostylis barbata Kunth. Abundant among *Saccharum* and in the beds of water courses.

Cyperus compressus Linn. Widely scattered among *Saccharum* in damp places.

Cyperus diffusus Vahl. Common in some ravines and in some thickets.

Cyperus distans Linn. Widely scattered; not common.

Cyperus radiatus Vahl.† "Local on the strand." (Gates.) Not observed in 1916–17.

Cyperus rotundus Linn.* Widely scattered at low altitudes.

Cyperus uncinatus Poir.* Widely distributed among *Saccharum* at low altitudes.

Fimbristylis merrillii Palla.* Rare in damp open places at low altitudes.

Fimbristylis polytrichoides R. Br.* Widely scattered in damp places at low altitudes; not common.

Fimbristylis squarrosa Vahl.* Widely distributed; locally abundant along the shore and in some ravines; scattered tufts occur within the crater.

Kyllinga monocephala (Linn.) Rottb.* A few plants observed at the base of bluffs along the beach.

Mariscus stuppeus (Forst.) Merr. Scattered along the beach and in some ravines.

Pycreus nitens (Vahl) Nees.* At the base of bluffs back of the beach; very local.

Pycreus holosericeus (Link.).* A few plants in damp soil along the strand.

Pycreus odoratus (Linn.) Urb.* Widely scattered at low altitudes.

Torulinium ferax L. C. Rich.* A single plant back of the beach on the west coast of the island.

ARACEAE

Amorphophallus campanulatus Roxb. *Poñgápong.* A few plants observed in ravines near Pirapiraso.

Pistia stratiotes Linn. *Quiápo.* Very local on the island for want of proper habitat; confined to a very few areas where stagnant water is found back of the beach. Commonly cast up on the beach by the waves.

LEMNACEAE

Lemna trisulca Hegelm.† *Lía.* "Washed up on the shore with *Pistia*." (Gates.) Not seen in 1916–17.

Spirodela polyrrhiza (Linn.) Schleid.* *Lía.* Rare and in small quantity on stagnant water at mouths of water courses.

PALMAE

Arenga saocharifera Labill. *Cáong.* A few young plants observed in ravines.

COMMELINACEAE

Aneilema malabaricum (Linn.) Merr.* Rare at low altitudes.

Commelina benghalensis Linn.* *Alicbáñgon.* In damp soil at low altitudes; rare.

Commelina nudiflora Linn. *Alicbáñgon.* Widely scatterred in thickets and ravines at low altitudes.

Cyanotis cristata (Linn.) R. & S.* Locally abundant in thickets near the beach.

DIOSCOREACEAE

Dioscorea bulbifera Linn. In thickets and ravines; rare.

Dioscorea luzoniensis Scharuer. *Cobag.* In thickets and ravines; common about Pirapiraso.

Dioscorea myriantha Kunth.* Rare; only a few plants observed.

Dioscorea triphylla Linn. (*D. daemona* Roxb.).* *Namí.* In thickets and ravines at Pirapiraso.

Dioscorea aculeata Linn.* *Tugui.* In thickets on bluffs along the northern coast of the island.

MUSACEAE

Musa sapientum Linn. var. *Ságuing.* Two forms or varieties occur on the island, both certainly persistent from plants existing before the eruption.

ORCHIDACEAE

Eulophia squalida Lindl.* Rare; observed in one ravine.

Hetaeria oblongifolia Blume.* A single juvenile plant observed in a damp cañon on the northern slope of the volcano.

ULMACEAE

Trema orientalis Blume (*T. amboinensis* auct., non Blume). *Hanarión.* Common and widely distributed.

MORACEAE

Allaeanthus luzonicus (Blanco) F.-Vill. *Himbabaó.* One tree observed near Pirapiraso.

Artocarpus lamellata Blanco (*A. nitida* Tréc.). *Anóbling.* A few trees observed near Pirapiraso.

Ficus concinna Miq.* *Baléte.* A single juvenile plant observed.

Ficus cumingii Miq. *Isís.* Widely scattered on open slopes and in ravines. A polymorphous species, presenting several forms, some of which intergrade with *F. ulmifolia* Lam.

Ficus hauili Blanco. *Hauíli.* Common and widely distributed in thickets, ravines, and open slopes at low altitudes.

Ficus indica Linn. *Baléte.* Widely distributed. Certainly persistent from trees existing before the eruption; one well-established tree, perhaps 4 or 5 meters high, occurs on the northern crater wall inside the crater. This may prove to be *F. retusa* Linn.

Ficus nervosa Heyne.† "Small shrub in parang." (Gates.) Not observed in 1916–17.

Ficus nota (Blanco) Merr.* *Tibíg.* Rare; a few plants at low altitudes.

Ficus odorata (Blanco) Merr.* *Paquíling.* Rare; a single tree observed.

Ficus tinctoria Forst. *Baléte na bató.* On cliffs along the coast; widely scattered.

Ficus stipulosa Miq.* *Baléte.* A single tree on the bluffs near the northern coast of the island.

Ficus ulmifolia Lam. *Isís.* Common and widely distributed.

Malaisia scandens (Lour.) O. Kuntze.* *Malaisís.* A few plants in thickets near Pirapiraso.

Streblus asper Lour. *Caliós.* Rare in thickets at low altitudes.

URTICACEAE

Boehmeria blumei Wedd.* Scattered in ravines.

Pipturus arborescens (Link.) C. B. Rob. *Dolónot.* Widely scattered in thickets at low altitudes.

Pouzolzia zeylanica (Linn.) Benn.* A few plants in damp open places at low altitudes; rare.

ARISTOLOCHIACEAE

Aristolochia tagala Cham.* *Malaúbi.* Not uncommon in thickets near Pirapiraso.

POLYGONACEAE

Polygonum barbatum Linn.* A few specimens observed immediately back of the beach on the eastern coast of the island.

AMARANTHACEAE

Aerua lanata (Linn.) Juss.† A few small plants observed by Gates near the strand; not seen in 1916–17.

Alternanthera sessilis (Linn.) R. Br. Scattered near the beach.

Amaranthus spinosus Linn. *Colítis.* Widely scattered near the beach.

Deeringia baccata (Retz.) Moq. Not uncommon in thickets near Pirapiraso; scattered in other parts of the island.

AIZOACEAE

Trianthema monogyna Linn.* A single plant near the beach on the eastern coast of the island.

PORTULACACEAE

Portulaca oleracea Linn. *Golisíman.* Along the beach; rare and widely scattered.

CERATOPHYLLACEAE

Ceratophyllum demersum Linn. A submerged aquatic cast up on the shore.

MENISPERMACEAE

Cissampelos pareira Linn. Scattered in thickets at the northern end of the island.

Pericampylus incanus Miers. In thickets near Pirapiraso.

ANNONACEAE

Annona reticulata Linn.* *Anónas.* One mature tree, bearing fruits, and a few small ones near Pirapiraso; a remnant from old cultivation.

LAURACEAE

Cassytha filiformis Linn. *Malabohóc.* In thickets near the beach at a few places along the western shore of the island.

Litsea glutinosa (Lour.) C. B. Rob. *Pusopuso.* Widely scattered in thickets, on open slopes, and in ravines.

CAPPARIDACEAE

Capparis horrida Linn. *Dauág.* In thickets and ravines; locally abundant.

Capparis micracantha DC. *Halobágat.* Much less common than the preceding species.

Crataeva religiosa Forst.† "Tree, invading parang." (Gates.) Not observed in 1916–17.

Polanisia viscosa DC. A few plants observed immediately back of the beach; widely scattered.

MORINGACEAE

Moringa oleifera Lam. *Malúngay.* Near Pirapiraso; a few trees, almost certainly persisting from before the eruption.

CONNARACEAE

Cnestis diffusa (Blanco) Merr.* Not uncommon in thickets along the northern coast of the island.

Rourea erecta (Blanco) Merr. *Camagsá.* In thickets and ravines; widely scattered but not abundant.

LEGUMINOSAE

Abrus precatorius Linn. *Saga.* Widely scattered at low altitudes.

Acacia farnesiana (Linn.) Willd. *Aróma.* Abundant.

Albizzia procera (Roxb.) Benth. *Acleng párang.* Common on slopes and in ravines at the northern end of the island.

Alysicarpus vaginalis DC. *Manimanúhan.* Fairly common among *Saccharum* at low altitudes.

Arachis hypogaea Linn. *Maní.* A few plants observed by Gates near Pirapiraso, and one or two in 1916–17.

Caesalpinia crista Linn.* *Calumbibít.* Scattered in thickets at low northern end of the island.

Canavalia ensiformis (Linn.) DC., forma. Abundant near the coast in ravines and thickets.

Canavalia lineata DC. *Patáning dágat.* Locally abundant along the beach.

Cantharospermum scarabaeoides (Linn.) Baill. Widely scattered among *Saccharum* at low altitudes.

Cassia alata Linn.* *Capúrco.* Rare; a few plants observed at low altitudes.

Cassia tora Linn.* *Catandáng áso.* Rare; a few plants observed at low altitudes.

Clitoria ternatea Linn.* A few plants at low altitudes; rare.

Crotalaria albida Heyne. Locally abundant among *Saccharum* at low altitudes.

Crotalaria acicularis Ham.* Locally abundant among *Saccharum* at low altitudes.

Crotalaria stenophylla Vog.* Widely scattered among *Saccharum* at low altitudes.

Crotalaria verrucosa Linn.* Rare; a few plants observed near the beach.

Derris polyantha Park. Common in thickets along the northern coast of the island.

Desmodium gangeticum (Linn.) DC. Widely distributed and common among *Saccharum* at low altitudes.

Desmodium procumbens Hitchc.* Rare; only a few plants observed.

Desmodium pulchellum Benth. Common among *Saccharum* at low altitudes.

Desmodium scorpiurus (Sw.) Desf. Common among *Saccharum* at low altitudes.

Desmodium triflorum (Linn.) DC. Common and widely distributed at low altitudes.

Erythrina indica Lam. *Dapdap.* Widely scattered; chiefly near the coast; rare.

Gliricidia sepium (Jacq.) Steud. *Madre cacáo.* Locally abundant; at the northern end of the island; probably persistent from trees existing before the eruption.

Mezoneurum latisiliquum (Cav.) Merr. *Cámot púsa.* On bluffs along the coast; not common.

Mucuna nigricans (Lour.) Steud.* *Nípai.* A few plants in thickets at the northern end of the island near the beach.

Pachyrrhizus erosus (Linn.) Urb. *Síncamas.* A few specimens observed in thickets at low altitudes; Gates observed a single plant.

Phaseolus adenanthus Mey.* Common and conspicuous in thickets along the northern and western coasts.

Pithecolobium dulce (Roxb.) Benth. *Camanchíle.* Widely distributed in ravines and thickets; almost certainly persistent from trees existing before the eruption.

Pongamia pinnata (Linn.) Merr. (*Millettia* sp., of Gates's list). *Balíc-balíc.* In ravines and thickets at low altitudes; not common.

Pueraria phaseoloides Benth.* In thickets and in *Saccharum* areas; widely scattered.

Samanea saman (Jacq.) Merr. (*Pithecolobium saman* Benth.).* *Acacia.* A single seedling observed back of the beach on the western coast.

Sesbania cannabina (Retz.) Pers. A few seedling observed on the eastern coast back of the beach; Gates reports it as abundant in one place in the northeastern part of the island.

Tephrosia dichotoma Desf. Widely distributed in *Saccharum* areas at low altitudes in the northern part of the island; locally abundant.

Vigna lutea A. Gray. Widely distributed in thickets along the beach.

Zornia diphylla Pers.* Locally abundant in talahib areas at low altitudes.

EUPHORBIACEAE

Antidesma bunius (Linn.) Spreng. *Bignay.* Scattered in thickets near Pirapiraso and in other parts of the island.

Antidesma ghaesembilla Gaertn. *Bignay pogo.* On lower slopes, in thickets, and in ravines; common and widely scattered, especially in the northern end of the island.

Antidesma rostratum Tul.† *Bignay pogo.* A few small trees recorded by Gates; not observed in 1916–17.

Breynia acuminata Muell.-Arg. *Matang ulang.* Scattered in thickets near Pirapiraso; a specimen collected by Gates was identified as *Phyllanthus reticulatus* Poir.

Breynia cernua (Poir.) Muell.-Arg. *Matang ulang.* In thickets near Pirapiraso.

Breynia rhamnoides (Retz.) Muell.-Arg. *Matang ulang.* In thickets near Pirapiraso, rare.

Bridelia stipularis (Linn.) Blume. *Lubálub.* Abundant in thickets at the northern end of the island.

Euphorbia hirta Linn.* *Botóbotónes.* Widely scattered near the coast; not common.

Fluggea virosa (Willd.) Baill. *Botólan.* Common in thickets, especially about Pirapiraso.

Glochidion rubrum Blume.* Rare; a few shrubs observed.

Glochidion triandrum (Blanco) C. B. Rob. Not uncommon in thickets near Pirapiraso.

Macaranga tanarius (Linn.) Muell.-Arg. *Binóñga.* Widely scattered in thickets and ravines.

Mallotus moluccanus Muell.-Arg. *Álim.* In thickets and ravines; widely scattered; locally common.

Manihot utilissima Pohl. *Camóting cáhoy.* A few plants observed in ravines near Pirapiraso, tending to become exterminated by the encroaching native vegetation; almost certainly persistent from plants existing before the eruption.

Phyllanthus erythrotrichus C. B. Rob. On bluffs near the coast, in ravines, and in thickets; widely distributed.

Ricinus communis Linn. *Táñgan-táñgan.* Widely scattared at low altitudes; mostly confined to the immediate vicinity of the beach.

ANACARDIACEAE

Dracontomelum cumingianum Baill.* *Lámio.* Only one tree observed.

Semecarpus cuneiformis Blanco. *Ligás.* Widely distributed on slopes and in ravines; almost certainly persistent from trees existing before the eruption.

CELASTRACEAE

Celastrus paniculata Willd. Not uncommon in thickets at the northern end of the islands.

SAPINDACEAE

Arytera littoralis Blume.* A few old trees near Pirapiraso.

Erioglossum rubiginosum (Roxb.) Blume.* In thickets near the coast at the northern end of the island; a few rather large specimens.

Otophora fruticosa Blume.* *Balinóno.* In thickets at Pirapiraso, locally common.

VITACEAE

Cissus repens Lam. *Pirápit hángin.* Widely scattered in thickets and in ravines; not common.

Columella (Cissus) trifolia (Linn.) Merr. *Calít-calít.* In ravines at low altitudes; scattered.

Tetrastigma harmandii Planch. *Áyo.* Scattered in ravines and thickets at low altitudes near Pirapiraso.

ELAEOCARPACEAE

Muntingia calabura Linn.† *Dátiles.* "Seedlings on the beach and trees in the parang on the slopes of Mount Ragatan." (Gates.) Not seen in 1916–17.

TILIACEAE

Corchorus acutangulus Lam.* *Pasáo-na-habá.* A few plants observed back of the beach at one place only.

Triumfetta bartramia Linn. *Colót colótan.* Widely scattered among *Saccharum* at low altitudes.

MALVACEAE

Hibiscus surattensis Linn.* A few plants found along the beach at the northern end of the island.

Sida acuta Burm. f. *Escóbang habá.* Widely scattered at low altitudes; nowhere common.

Sida rhombifolia Linn. Scattered at low altitudes; not common.

Urena lobata Linn.* *Colót colótan.* Scattered in the *Saccharum* areas, but not abundant.

BOMBACACEAE

Ceiba pentandra (Linn.) Gaertn. *Bóboy.* Widely scattered in thickets and ravines; the older trees almost certainly persisting from plants growing before the eruption.

STERCULIACEAE

Sterculia foetida Linn. *Calumpang.* Widely scattered on grassy slopes; certainly persisting from trees existing before the eruption.

Waltheria americana Linn. Widely distributed in the *Saccharum* areas at low altitudes.

GUTTIFERAE

Cratoxylon blancoi Blume. *Gúyong-gúyong.* Widely scattered; Gates observed this sprouting from buried stumps.

FLACOURTIACEAE

Casearia cinerea Turcz. Common in thickets and ravines at low altitudes.

Flacourtia rukam Z. & M.* Rare and local; a few plants observed.

CARICACEAE

Carica papaya Linn. *Papaya.* Scattered in ravines and thickets at low altitudes, especially at the northern end of the island.

THYMELAEACEAE

Phaleria cumingii F.-Vill.† "A vine in parang thicket; infrequent." (Gates.) Not seen in 1916–17. Gates's specimen is sterile, but the identification is apparently correct, although the plant is not a vine.

ELAEAGNACEAE

Elaeagnus philippensis Perr.† *Alingaró.* "Vine in parang; infrequent." (Gates.) Not observed in 1916–17.

COMBRETACEAE

Quisqualis indica Linn. *Nióg niógan.* Along the northern coast and in thickets about Pirapiraso.

Terminalia catappa Linn.* *Talísay.* A few young trees observed; widely scattered back of the beach.

MYRTACEAE

Eugenia jambolana Lam. *Duhat.* Widely distributed in thickets and in some ravines; common. This is almost certainly persistent from trees existing before the eruption, as some plants were found where the shoots had grown from the broken trunks of very old trees, in one case the old trunk being 40 cm in diameter.

Psidium guajava Linn. *Bayabas.* Widely distributed at low altitudes; common.

OENOTHERACEAE

Jussiaea repens Linn. A few juvenile plants observed in damp soil near the beach.

Jussiaea linifolia Vahl.* A few widely scattered individuals observed along the beach.

UMBELLIFERAE

Centella asiatica (Linn.) Urb.* *Taquip cohól.* Abundant locally, in damp soil back of the beach at the northern end of the island.

MYRSINACEAE

Maesa cumingii Mez. Not uncommon in ravines and in thickets at the northern end of the island; widely scattered.

Maesa laxa Mez.* Less common than than the preceding species.

LOGANIACEAE

Buddleia asiatica Lour. Scattered on bluffs near the beach.

Mitrasacme alsinoides R. Br.* Widely scattered among *Saccharum* at low altitudes; on the walls of cañons and ravines.

APOCYNACEAE

Aganosma acuminata G. Don.* A few plants on slopes and in ravines near Pirapiraso.

Alstonia macrophylla Wall.* *Batíno.* Rare; only one or two young trees observed.

Alstonia scholaris (Linn.) R. Br. *Ditá.* Very widely scattered at the northern end of the island.

Tabernaemontana pandacaqui Poir. *Pandacáqui.* Locally abundant in thickets and in ravines.

Tabernaemontana subglobosa Merr. *Pandacáqui.* More abundant and more generally distributed than the preceding species.

Wrightia laniti (Blanco) Merr. *Laníti.* Widely distributed in ravines, thickets, and sometimes on open slopes, not abundant.

ASCLEPIADACEAE

Calotropis gigantea R. Br.* *Capól-capól.* A few individuals at low altitudes; rare.

Gymnema pachyglossum Schltr. In thickets near the shore at the northern end of the island; locally common.

Gymnema tingens W. & A.† (*Parsonsia ?* of Gates's list.) "A small vine in the parang." (Gates.) Not found in 1916–17.

Streptocaulon baumii Dcne. Common in thickets and widely distributed.

Tylophora perrottetiana Dcne.* In thickets along the northern coast; rare and widely scattered.

CONVOLVULACEAE

Calonyction album (Linn.) House.* In thickets at the northern end of the island, especially near the coast; ascending to the tops of the hills near Pirapiraso.

Hewittia sublobata (Linn. f.) O. Kuntze. Widely scattered at the northern end of the island at low altitudes; locally abundant.

Ipomoea batatas (Linn.) Poir.† *Camote.* "A few vines near Pirapiraso." (Gates.) Not seen in 1916–17.

Ipomoea obscura (Linn.) Ker. Widely distributed on slopes at low altitudes; not abundant.

Ipomoea pescaprae (Linn.) Roth. *Lampáyong.* In many places abundant on the beach; in some places extending inland up slopes for considerable distances.

Ipomoea paniculata R. Br.* In thickets near the beach; widely scattered.

Ipomoea pestigridis Linn. Widely scattered at low altitudes in *Saccharum.*

Ipomoea reptans (Linn.) Poir.* *Cancóng.* A single plant observed in damp soil near the beach.

Ipomoea triloba Linn. Scattered at low altitudes; not common.

Operculina turpethum (Linn.) Manso. In thickets and ravines; widely scattered.

Stictocardia campanulata (Linn.) Merr.* Scattered in thickets along the northern coast of the island.

BORAGINACEAE

Cordia myxa Linn. (*C. blancoi* Vid.) *Anónang.* Widely scattered on slopes, in thickets, and in ravines; fairly common.

Heliotropium indicum Linn. *Trompa elefánte.* Widely scattered in damp soil near the beach; not common.

Tournefortia sarmentosa Lam. Not uncommon in thickets at the northern end of the island.

Trichodesma zeylanicum R. Br.* A number of plants were observed in one locality near the beach east of Pirapiraso.

VERBENACEAE

Callicarpa blancoi Rolfe. *Tubang dalág.* Abundant and widely distributed on open slopes and in ravines.

Clerodendron minahassae T. & B. *Bagáuac.* Widely scattered at low altitudes, in thickets and in ravines.

Gmelina philippensis Cham.* *Alípung.* Widely scattered on open slopes; not abundant.

Premna nauseosa Blanco. *Alagáo.* On open slopes; widely scattered.

Premna odorata Blanco.* *Alagáo.* In thickets and ravines near Pirapiraso.

Vitex parviflora Juss. *Moláve.* One tree observed by Gates; collected in 1916; rare.

Vitex trifolia Linn.* *Lagúndi.* Rare; a few plants at low altitudes.

LABIATAE

Anisomelis indica (Linn.) O. Kuntze.* *Talingharáp.* Scattered in ravines and thickets near Pirapiraso.

Hyptis suaveolens (Linn.) Poir.* *Soob cabáyo.* A few plants observed at Pirapiraso.

Leucas javanica Blume. Widely scattered in grasslands at low altitudes; not common.

SOLANACEAE

Capsicum fruticosum Linn.* *Sili.* Widely scattered in ravines and thickets near Pirapiraso.

Datura alba Nees. *Talampúnai.* Scattered in low lands near the coast, especially near Pirapiraso.

Lycopersicum esculentum Mill. *Camátes.* A few, widely scattered, fruiting specimens observed at low altitudes; the wild form with small fruits.

Physalis minima Linn.* Scattered individuals near the coast in the vicinity of Pirapiraso.

Solanum cumingii Dunal.* A few plants in open places at low altitudes; rare.

Solanum nigrum Linn.* A few plants observed near the beach.

Solanum verbascifolium Linn.* Widely scattered at the northern end of the island; not common.

SCROPHULARIACEAE

Bonnaya brachiata L. & O.* Widely scattered at low altitudes among *Saccharum.*

Lindenbergia philippensis (Cham.) Benth. Local; observed only on the walls of cañons and ravines.

Pyxidaria pusilla (Thunb.) Merr. (*Vandellia pusilla* Merr., *V. scabra* Benth.) Local among grasses in open damp soil.

Pyxidaria crustacea (Linn.) F. Muell. Widely scattered at low altitudes.

Scoparia dulcis Linn. Widely scattered at low altitudes; nowhere common.

Torenia peduncularis Benth.* A single plant near Pirapiraso.

BIGNONIACEAE

Oroxylum indicum (Linn.) Vent. *Píncapíncahan.* Widely scattered; nowhere abundant.

ACANTHACEAE

Blechum brownei Nees.* Scattered in thickets near Pirapiraso; rare.

Hemigraphis rapifera Hallier f.* A few plants observed in ravines.

Hygrophila angustifolia R. Brown.* *Mamitíc.* A few juvenile plants in damp soil back of the beach.

RUBIACEAE

Hedyotis tenelliflora Blume.* Rare; a few plants observed in open damp soil.

Morinda bracteata Roxb. *Bancúdo.* Common and widely distributed.

Mussaenda philippica L. C. Rich.* *Cáhoy dalága.* Scattered in thickets near Pirapiraso; fully matured individuals in full anthesis.

Neonauclea bartlingii (DC.) Merr.* A single seedling observed in damp ravine on the outer slopes of the crater rim and two or three near the base of the northeastern wall inside of the crater.

Oldenlandia corymbosa Linn. Widely scattered at low altitudes, but not abundant.

Spermacoce hispida Blume. Widely scattered; not common.

Wendlandia luzonensis DC. In ravines near Pirapiraso; widely scattered.

CUCURBITACEAE

Bryonopsis laciniosa Naud.* Widely scattered in thickets near the beach; rare.

Citrullus vulgaris (Linn.) Schrad.† *Pacúan.* "Local on the strand." (Gates.) Not found in 1916–17.

Cucurbita maxima Duch.* *Calabáza.* A single young plant observed back of the beach along the western shore of the island.

Luffa cylindrica (Linn.) Roem. *Patóla.* Widely scattered, especially near the beach; the wild form.

Melothria mucronata (Blume) Cogn.* In thickets near Pirapiraso; not common.

Momordica charantia Linn. *Ampalaya.* Widely scattered at low altitudes; not abundant.

Momordica cochinchinensis (Lour.) Spreng. *Búyoc-búyoc.* In thickets and ravines; fairly common at the northern end of the island.

Mormordica ovata Cogn. *Búyoc-Búyoc.* Associated with the preceding but more abundant; this differs from the preceding only in its entire, not lobed leaves and is probably not specifically distinct.

COMPOSITAE

Ageratum conyzoides Linn. *Bulac manóc.* Common among *Saccharum* at low altitudes.

Blumea balsamifera (Linn.) DC. *Sambóng.* Locally abundant in ravines etc.; only three plants observed by Gates.

Blumea lacera DC. Widely scattered in ravines and among coarse grasses; a few plants inside of the crater.

Blumea mollis (Don) Merr.* Widely scattered at low altitudes, especially in ravines.

Blumea glomerata DC.* Abundant on the walls of a single damp ravine at the northern end of the island.

Eclipta alba (Linn.) Hassk. Widely scattered at low altitudes near the beach.

Eclipta zippeliana Blume.* A few plants observed near the beach at the northern end of the island.

Emilia sonchifolia (Linn.) DC. In ravines at low altitudes; widely scattered, but not abundant.

Erigeron linifolius Willd. Widely scattered at low altitudes; not abundant; a few plants inside the crater.

Pterocaulon cylindrostachyum C. B. Clarke. On dry open slopes; locally abundant, but of very limited distribution.

Sphaeranthus africanus Linn.* Two or three plants observed back of the beach along the northern coast of the island.

Synedrella nodiflora (Linn.) Gaertn. Rare and very widely scattered at low altitudes.

Vernonia cinerea (Linn.) Less. Widely distributed, but nowhere abundant.

Vernonia patula (Ait.) Merr.* A few widely scattered individuals were observed, chiefly near the beach at the northern end of the island.

Wedelia biflora (Linn.) R. Br. *Hagonoy.* In thickets near the beach.

SUMMARY

The vegetation of Volcano Island before the eruption of 1911 consisted of a mixture of grass and small trees, which covered all parts of the island except the slopes of the main crater and Mount Tabaro and the dry stream beds.

The eruption of 1911 completely destroyed the vegetation over most parts of the island, while in the extreme northern part a few bamboos, bananas, trees, and possibly some grass escaped.

In the revegetation of the island a single species of grass, *Saccharum spontaneum*, is so much the most prominent of all the invaders that it gives character to the whole vegetation. Except in the northern part of the island, it occurs as scattered clumps. Besides *Saccharum* the other most conspicuous elements are scattered trees.

The revegetation is proceeding slowly owing, probably, to adverse environmental conditions, the most prominent of which are the presence of excessive amounts of sulphates in the soil; the lack of weathering of the soil particles; the scarcity or absence of humus; the scarcity of nitrogen; the low water-holding capacity of the soil; and erosion.

Two hundred ninety-two species of plants have been found on Volcano Island since the eruption. These represent 232 genera and 66 families.

Most of the species of plants on Volcano Island are those of wide geographic distribution. Ninety-six, or 36 per cent, are found in the tropics of both hemispheres, while an additional one hundred fifty, or 51 per cent, are found in other parts of the Indo-Malayan regions as well as in the Philippines.

Very few of the species of plants on Volcano Island have found favorable habitats over any considerable area, as only 13 are common and widely distributed.

Birds seem to have been the most important agency in bringing different species to Volcano Island, as 54 per cent of the total on the island could have been carried to it by this means.

ILLUSTRATIONS

PLATE IV

Relief map of Volcano Island before the eruption of 1911. The only changes caused by the last eruption that were of sufficient magnitude to show on this relief map are within the crater, the center of which is now occupied by a single large lake (Plate XVI, fig. 2). (Map prepared in the division of mines, Bureau of Science.)

PLATE V

FIG. 1. Photograph taken in December, 1909, to show erosion on the southwestern slopes of Taal Volcano. On the right is Taal Volcano, while Mount Tabaro is on the left. The center of the picture is occupied by the prominent dry stream bed extending southwest toward Mount Saluyan. In the foreground is a small ridge with scattered clumps of grass. The dry stream bed contains a few trees and very widely spaced clumps of grass. The slopes are apparently bare, but may have supported scattered tufts of grass.

2. View of the southeastern slopes of Volcano Island from Lake Bombon, April, 1908. The steep slopes of the main cone appear to be very bare, while the lower and more level ground is covered with vegetation in which trees predominate.

PLATE VI

FIG. 1. View of the southeastern shore of Volcano Island and Taal Volcano during the period of activity in 1911 and the day before the great eruption that destroyed the vegetation. Near the lake the vegetation consists largely of grass, while trees are more prominent farther inland.

2. The northern slopes of Mount Binintiang Malaqui at the northwestern point of Volcano Island, December, 1909. The cone is covered with vegetation in which trees are very prominent.

PLATE VII

FIG. 1. The effect of the mud blast on a tree at Gulod, on the mainland, about 8 kilometers from the crater. Natural size. (Photograph by Martin.)

2. A tree 15 centimeters in diameter broken by the force of the eruption and the bark and wood shreded by the mud driven by the force of the eruption. (Photograph by Martin.)

PLATE VIII

FIG. 1. The site of the former village of Pirapiraso, in the northern part of the island, immediately after the eruption. Most of the trees in the foreground are broken off close to the ground; also on the hills in the background some of the trees are broken, and all of them are leafless. The ground between the beach and the hills is apparently covered with ash. (Photograph by Martin.)

2. View from the shore looking east toward the two old craters south of Mount Balantoc, October, 1916. The relative abundance and size of the clumps of *Saccharum* is well indicated. The ground between the clumps of *Saccharum* is sparsely covered by low or creeping grasses and sedges. A few bushes are seen in the background.

PLATE IX

FIG. 1. *Ipomoea pes-caprae* growing along the shore and upon the slopes between clumps of *Saccharum*. Southern shore of Volcano Island, west of Calauit Point, October, 1916.

2. Southern slopes of Mount Binintiang Malaqui, as seen from Guano Point. To the right in the foreground is the end of a deltal fan. The low ridge back of this is the western end of Mount Balantoc, which supports scattered clumps of grass and some trees. The trees on Mounts Balantoc and Binintiang Malaqui are seen as dark spots in the picture. The trees on the latter mountain are widely scattered. They are about as prominent on the other slopes of the mountain as in this picture. A comparison of this view, taken October, 1916, with Plate VI, fig. 2, shows that trees are much less abundant at the present time than before the eruption.

PLATE X

FIG. 1. The foot of Mount Balantoc, near the former town of Panipihan. (Photograph by Gates, April 18, 1914.)

2. South from the summit of Mount Binintiang Malaqui. In the foreground is a horseshoe ridge, Mount Balantoc; in the background, the crater with its high southern wall; in the extreme background is Mount Macolod on the mainland. In the background on the right from the center are Mounts Tabaro and Saluyan. The scattered nature of the vegetation on Mount Balantoc is very evident. (Photograph by Gates, April 18, 1914.)

3. View looking north from near the crater rim toward Mount Tibag in the north-central region. The vegetation is almost entirely *Saccharum spontaneum.* (Photograph by Gates. October 25, 1913.)

PLATE XI

FIG. 1. View of the southern slope of the northwestern end of Mount Balantoc. The vegetation consists mostly of widely spaced clumps of *Saccharum spontaneum* with scattered trees. October, 1916.

2. The northwestern part of Volcano Island from the rim of the crater where Mount Pinag-ulbuan joints the main cone. In the background is Talisay Ridge on the mainland. The cone at the end of Volcano Island is Mount Binintiang Malaqui. In front of

this is Mount Balantoc. In the foreground are the lower slopes of the main cone. The vegetation on Mount Binintiang Malaqui is largely *Themeda gigantea* and *Saccharum spontaneum*. The remainder of the vegetation shown consists very largely of an open stand of *Saccharum*. On Mount Balantoc are seen a considerable number of scattered trees. October, 1916.

PLATE XII

FIG. 1. The central region of the northern part of Volcano Island, from the crater rim where Mount Pinag-ulbuan joins the main cone. The prominent peak on the right is Mount Mataas-na-golod. On the extreme left is Mount Tibag. The vegetation throughout is very largely an open stand of *Saccharum spontaneum*. October, 1916.

2. The northwestern slopes of the southwestern peninsula of Volcano Island as seen from Malanao Point. On the right is Mount Binintiang Munti; on the left, Mount Saluyan. The dark spots represent scattered trees. The remainder of the vegetation is very largely an open stand of *Saccharum spontaneum*. On account of the distance at which the photograph was taken the bare ground between the clumps of *Saccharum* is not shown plainly. October, 1916.

PLATE XIII

FIG. 1. View of the southern portion of Volcano Island from Calauit Point. In the distance is the crater of Taal Volcano, the high portion on the left being the southwestern part of the rim. The vegetation consists almost entirely of very scattereing clumps of *Saccharum spontaneum*. October, 1916.

2. The prominent dry stream bed, extending southwest from the southwestern part of the rim of the crater. In the picture is seen that part of the stream bed where it curves around Mount Saluyan, the lower slopes of which are to the right. The effects of erosion are very evident. No plants occur in the dry stream bed. Elsewhere the vegetation consists almost entirely of very scattering clumps of *Saccharum spontaneum*, there being only about six shrubs visible in the picture. October, 1916.

PLATE XIV

FIG. 1. A deltal fan on the western side of Volcano Island. View from near Pandac-na-lon̄gos point toward the southeast. In the background on the left is the southwestern part of the rim of the crater; on the right is a low ridge, behind which can be seen a portion of the flattened top of Mount Tabaro. In the center of the picture is a dry stream bed running through the deltal fan. The only vegetation seen on the fan consists of very few scattered clumps of *Saccharum spontaneum*. On the low hills in the distance scattered clumps of *Saccharum* are more numerous. October, 1916.

2. View of the source of the prominent dry stream bed shown in plate X fig. 2, which extends from the southwestern part of the main

cone toward Mount Saluyan. In the background on the left is Mount Tabaro, on the right is the main crater. The vegetation consist of a very sparse development of *Saccharum*, a few clumps of which are seen in the foreground. In the remainder of the area the tufts of *Saccharum* are too small and scarce to show in the picture. A comparison of this view with plate II, fig. 1, shows that vegetation was very scarce in this area before the eruption and consisted of a few trees or shrubs and small scattered clumps of a grass, probably *Saccharum spontaneum*.

PLATE XV

FIG. 1. The outer slopes of the crater of Taal Volcano as seen from the southeast. The effect of erosion on the topography is very marked. The vegetation is composed practically entirely of scattered clumps of *Saccharum spontaneum*. On the upper slopes *Saccharum* is reduced to very small tufts. October, 1916.

2. The crater of Taal Volcano, as seen from the southern rim. Owing to the steepness of the slope and the rapidity of erosion, the walls are largely bare. The gentle slopes within the crater support scattered clumps of *Saccharum spontaneum* and a few individuals of two sedges. October, 1916.

PLATE XVI

FIG. 1. A typical cañon on the slopes of Taal Volcano.

2. Effect of erosion on the southwestern slopes of Taal Volcano.

TEXT FIGURES

FIG. 1. Map of Volcano Island, Lake Bombon, and the surrounding country. (Depths and elevations are given in meters.)

2. Map published by Gates to show the revegetation of Volcano Island. The numbers indicate the plant associations as interpreted by Gates. 1, *Vallisneria* association, apparently indicated largely by fragments thrown up on the beach; 2, 3, 4, and 5 represent marsh or strand vegetation that has apparently disappeared through the action of erosion; 6, *Ipomoea pes-caprae*; 7, grass; 8 and 9, shrubs and trees, apparently occurring largely as scattered individuals.

PLATE IV. RELIEF MAP OF VOLCANO ISLAND.

Fig. 1. Southeastern slopes of Taal Volcano in 1909.

Fig. 2. Southeastern shore of Volcano Island in 1908.

PLATE V.

Fig. 1. Southeastern shore of Volcano Island in 1911.

Fig. 2. The northern slopes of Mount Binintiang Malaki in 1909.

PLATE VI.

Fig. 1. The effect of the eruption on a tree about 8 kilometers from the crater.

Fig. 2. A tree, 15 centimeters in diameter, broken by the eruption.

PLATE VII.

Fig. 1. Site of village of Pirapiraso after the eruption.

Fig. 2. Average stand of Saccharum spontaneum in 1916.

PLATE VIII.

Fig. 1. Ipomoea pes-caprae and Saccharum spontaneum.

Fig. 2. Mount Binintiang Malaki in 1916.

PLATE IX.

Fig. 1. Foot of Mount Balantoc in 1914.

Fig. 2. Northwestern part of Volcano Island in 1914.

Fig. 3. North-central region of Volcano Island in 1914.

PLATE X.

Fig. 1. Vegetation on Mount Balantoc in 1916.

Fig. 2. Northwestern part of Volcano Island in 1916.

PLATE XI.

Fig. 1. Mount Mataas-na-golod in 1916.

Fig. 2. Southwestern peninsula of Volcano Island in 1916.

PLATE XII.

Fig. 1. Southern portion of Volcano Island in 1916.

Fig. 2. A dry stream bed in 1916.

PLATE XIII.

Fig. 1. A deltal plain in 1916.

Fig. 2. Southwestern slopes of Taal Volcano in 1916.

PLATE XIV.

Fig. 1. Panorama of Taal Volcano in 1916.

Fig. 2. Panorama of Taal crater in 1916.

PLATE XV.

Fig. 1. Canyon on Volcano Island.

Fig. 2. Erosion on Taal Volcano.

PLATE XVI.

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THE AMBOINA ORCHIDACEAE COLLECTED BY C. B. ROBINSON

By J. J. SMITH [1]
(*Buitenzorg, Java*)

The Robinson collection of *Orchidaceae* contained forty-one numbers, representing thirty-nine species; one species was sterile and could not be identified. Eleven species are new to Amboina:

Platanthera Robinsonii J. J. Sm.
Habenaria amboinensis J. J. Sm.
Didymoplexis minor J. J. Sm. var. *amboinensis* J. J. Sm.
Hetaeria oblongifolia Bl.
Goodyera rubicunda Lindl. var. *amboinensis* J. J. Sm.
Dendrobium acuminatissimum Lindl.
Dendrobium Robinsonii J. J. Sm.
Phreatia potamophila Schltr. (?)
Phalaenopsis Robinsonii J. J. Sm.
Palaenopsis Hebe Reichb. f. (var.).
Taeniophyllum minutiflorum J. J. Sm.

Among these, five species and two varieties are here described for the first time.

Fifteen species have been identified with species described by Rumphius, of which all but one, *Zeuxine amboinensis* J. J. Sm., have already been enumerated in "Die Orchideen von Ambon."[2]

[1] The Robinson collection of Amboina Orchidaceae was sent to Leiden, where the present paper was prepared by Doctor Smith. On his return to Buitenzorg, Doctor Smith considered it inadvisable to take the specimens or his manuscript with him, on account of the abnormal conditions brought about by the war. His report on the Rumphian Orchidaceae [Merrill, An Interpretation of Rumphius's Herbarium Amboinense (1917) 168–179] was prepared at Buitenzorg *de novo*, without access to Robinson's specimens. A copy of his manuscript sent from Leiden was lost in transit. A second copy, forwarded later, was received at Buitenzorg about the middle of June, 1917, and in Manila July 11, 1917. This copy was received when my Interpretation of Rumphius's Herbarium Amboinense was in page proof, but the specimens representing Rumphian species were cited in the Addenda, pages 549, 550. [E. D. M.]

[2] Smith, J. J., Die Orchideen von Ambon (1905) 1–125.

Angraecum jamboe Rumph., which I formerly identified with *Dendrobium pruinosum* T. et B. and which Doctor Robinson thought to be *Pseuderia foliosa* Schltr., is probably neither of these species. In fact Rumphius's description of *Angraecum jamboe* suits entirely neither *Pseuderia foliosa* nor *Dendrobium pruinosum*, but it seems rather certain that he had in mind a species of *Dendrobium* of the section *Grastidium*.

I repeat here the Rumphian species, which are represented in the Robinson collection.

Platanthera Susannae Lindl.=*Flos Susannae* Rumph.

Habenaria Rumphii Lindl.=*Orchis amboinica minor* Rumph.; *Flos Susannae minor* Rumph.

Anoectochilus Reinwardtii Bl.=*Folium petolatum femina s. vera* Rumph.

Zeuxine amboinensis J. J. Sm.=? *Folium petolatum mas* Rumph.

Coelogyne Rumphii Lindl.=*Angraecum nervosum* Rumph.

Calanthe veratrifolia R. Br.=*Flos triplicatus* Rumph.

Spathoglottis plicata Bl.=*Angraecum terrestre primum purpureum* Rumph.

Dendrobium papilloniferum J. J. Sm.=*Angraecum crumenatum* Rumph.

Dendrobium ephemerum J. J. Sm.=*Angraecum album minus* Rumph.

Dendrobium moluccense J. J. Sm.=*Herba supplex minor* Rumph.

Dendrobium purpureum Roxb.=*Angraecum purpureum silvestre* Rumph.

Grammatophyllum scriptum Bl.=*Angraecum scriptum* Rumph.

Phalaenopsis amabilis Bl.=*Angraecum album majus* Rumph.

Luisia confusa Reichb. f.=*Angraecum flavum decimum s. angustifolium* Rumph.

Renanthera moluccana Bl.=*Angraecum rubrum* Rumph.

PAPHIOPEDILUM Pfitzer

PAPHIOPEDILUM MASTERSIANUM Pfitz. in Engl. Bot. Jahrb. 19 (1894) 40.

AMBOINA, cultivated by a native at Asiloeloe, *Reliquiae Robinsonianae 1619*, October 5, 1913.

PLATANTHERA L. C. Richard

PLATANTHERA SUSANNAE (Linn.) Lindl. Gen. et Sp. Orch. (1835) 295.

Flos susannae Rumph. Herb. Amb. 5: 286, *t. 99*.

AMBOINA, Soja road and Way tommo, *Robinson Pl. Rumph. Amb. 9*, August 1 and 9, 1913. Terrestrial, on grassy hillsides, altitude 20 to 150 meters.

PLATANTHERA ROBINSONII sp. nov.

Folia radicalia petiolata, lanceolata, breviter acuminata, acuta, margine minute undulata, costa media dorso prominente, nervis 2 majoribus et 2–3 tenuioribus utrinque, oblique reticulato-venosa, c. 7 cm longa, 2.1 cm lata, petiolo c. 4 cm longo. Inflorescentia erecta, laxe pluriflora, pedunculo c. 28 cm vel plus longo,

inferne folium erecto-patens foliis radicalibus simile sed vagina c. 1.5 cm longa instructum ceterum vaginulas c. 6–7 foliaceas patentes ovato-lanceolatas acute acuminatas marginibus et costa media decurrentes superne decrescentes et in bracteas vergentes gerente, rachide elongata, sicco angulata, glabra. Bracteae ovatae, sensim longius acuminatae, acutiusculae, concavae, basi 1-, supra basin 5-nerviae, ad c. 1.3 cm longae, 0.43 cm latae. Flores c. 9–14, toti c. 1.25 cm longi. Sepalum dorsale erectum, ovatum, apice conduplicatum, obtusum, concavum, 3-nervium, costa media dorso prominente, nervis exterioribus brevibus tenuibusque, c. 0.46 cm longum, 0.325 cm latum. Sepala lateralia patentissima, superne oblique recurva, oblique lineari-oblonga, basi subfalcatula, obtusa, margine apicali incurva, convexa, nervo intermedia dorso prominente, c. 0.55 cm longa, 0.15 cm lata. Petala erecta, semiovato-oblonga, supra basin acuminato-angustata, obtusa, basi lata concavula, 2-nervia, nervo antico inconspicuo, bene 0.5 cm longa, basi 0.225 cm lata. Labellum deflexum, simplex, ligulatum, apicem versus sensim leviter angustatum, obtusum, 5-nervium, c. 0.65 cm longum, basi 0.15 cm latum; calcar dependens, inferne ovario adpressum, incurvum, laminam superans, teres, obtusum, c. 0.775 cm longum. Gynostemium c. 0.225 cm longum, auriculis parvis verruculosis. Anthera brevis, latissima, apice late excisa, thecis valde remotis, parvis, clavatis. Ovarium 6-sulcatum, c. 1.3 cm longum.

AMBOINA, Mount Salahoetoe, *Reliquiae Robinsonianae 1639*, November 27, 1913. Terrestrial, altitude 850 meters; flowers greenish.

The plant seems to be closely allied to *Platanthera halconensis* (Ames) Schltr., from which it differs in its smaller flowers; blunt lateral sepals; and differently shaped petals. The basal leaves of *P. halconensis* are still unknown.

PERISTYLUS Blume

PERISTYLUS CANDIDUS J. J. Sm. Fl. Buit. 6 (1905) Orch. 36.

AMBOINA, Soja road, *Reliquiae Robinsonianae 1625*, August 1, 1913. Terrestrial, altitude 200 to 300 meters; flowers white; basal leaves usually four.

HABENARIA Willdenow

HABENARIA RUMPHII Lindl. Gen. et Sp. Orch. (1835) 320.

Orchis amboinica minor Rumph. Herb. Amb. 6: 118, *t. 54, f. 2.*
Flos susannae minor Rumph. op. cit. 5: 287.

AMBOINA, Soja road, *Robinson Pl. Rumph. Amb. 11*, August 1, 1913. Terrestrial, on grassy hillsides, altitude 100 to 300 meters.

HABENARIA AMBOINENSIS sp. nov.

Caulis erectus, c. 40 cm longus, inferne vaginis tubulosis tectus, superne foliatus. Folia c. 10, basin caulis versus in vaginas

vergentia, superne decrescentia, erecto-patentia, lanceolata, acuta, longe mucronata, basi angustata, costa media dorso carinata, reticulato-venosa, ad c. 12.5 cm longa, 2.3 cm lata; vaginae tubulosae. Inflorescentia erecta laxe c. 13-flora, secunda (?), pedunculo c. 11 cm longo, vaginulis c. 6–7 erectis laxe adpressis foliaceis superne decrescentibus et in bracteas vergentibus lanceolatis longe acuminatis donato, rachide c. 10 cm longa. Bracteae erectae, lanceolatae, longissime et acutissime acuminatae, concavae, margine minutissime papillosae, nervis 3 majoribus, costa media dorso prominente, reticulato-venosae, ad c. 4 cm longae, c. 0.77 cm latae. Flores erecti, toti c. 3 cm longi. Sepalum dorsale erectum, galeiforme, marginibus apiceque recurvum, subovatum, sensim angustatum, obtusum, nervis 3 dorso prominentibus, c. 1.1 cm longum. Sepala lateralia divergentia, oblique ovato-lanceolata, apicem versus sensim angustata, anguste obtusa, medio concavo-depressa, nervis 3 dorso prominentibus, c. 1.2 cm longa, 0.4 cm lata. Petala a sepalo dorsali libera, profunde bipartita, lacinia postica erecto-patente cum sepalo intermedio angulum acutum faciente, recta, lineari-subulata, acutiuscula, 2-nervia, usque ad basin c. 1.15 cm longa, basi 0.3 cm lata, lacinia antica longiore, arcuato-adscendente, lineari-filiformi, acuta, nervo 1 a nervo antico laciniae posticae emisso, c. 1.5 cm longa, supra basin 0.06 cm lata. Labellum alte 3-partitum, reflexum, laciniis lateralibus patentissimis, incurvis, filiformibus, c. 1.65 cm longis, vix 0.03 cm latis, lacinia intermedia deflexa, superne incurvula, linearі, convexa, nervia, c. 1.8 cm longa, 0.1 cm lata; calcar deorsum spectans, rectum, infra medium inflatum, apicem versus sensim attenuatum, acutum, c. 2.1 cm longum. Gynostemium cum processibus stigmatis c. 0.6 cm longum, auriculis majusculis, verruculosis. Anthera erecta, apice retusa, dorso convexa, thecis parallelis, clavatis, canalibus porrectis. Rostelli lobus intermedius erectus, triangulus, thecis multo brevior; crura porrecta, linearia, canaliculata. Processus stigmatici decurvi, basi labelli adpressi, oblongi, obtusi, convexi, crura rostelli subaequantes. Ovarium breviter petiolatum, curvulum, 6-sulcatum, c. 1.9 cm longum, pedicello c. 0.3 cm longo.

AMBOINA, Hatiwe, *Robinson Pl. Rumph. Amb. 14*, September 15, 1913, in light forests, altitude 250 meters. Flowers green, the column white.

The nearest allies of this species are probably *Habenaria dracaenifolia* Schltr., *H. keyensis* Schltr., and *H. bantamensis* J. J. Sm. The specimen does not represent any of the species described by Rumphius as Doctor Robinson supposed.

The plant differs from *H. dracaenifolia* in its smaller leaves, hardly acuminate sepals, the petals not cohering with the dorsal sepal, and provided with a short enterior lacinia, shorter lateral lobes, and the spur

dilated above the base and longer than the ovary; from *H. epiphylla* by its smaller leaves, broader dorsal sepal, the posterior lacinia of the petals straight and the anterior one shorter, and shorter lobes of the lip; from *H. bantamensis* by the broader gradually narrowed leaves, more numerously flowered spike, the sepals not acuminate, the petals with a shorter and broader posterior lacinia, shorter and unequal lobes of the lip, a longer spur, and smaller staminodes; and from *H. keyensis* Schltr. by the lateral sepals not being acuminate, the longer anterior lacinia of the petals, the shorter lacinia of the lip, the longer straight spur, and the stigmata nearly equaling the anther canals in length.

Doctor Robinson suggested in his field notes, that the plant might be *Orchis amboinica minor altera* Rumph. Herb. Amb. 6: 118, *t. 54, f. 3*. This, however, certainly is not the case. Rumphius's plate represents a plant with broader leaves and much smaller flowers, while his description does not at all suit Robinson's plant. Rumphius's figure represents a species of *Peristylus*.

The species belongs to the *Salaccensis* section.

DIDYMOPLEXIS Griffith

DIDYMOPLEXIS MINOR J. J. Sm. in Bull. Inst. Bot. Buit. 7 (1900) 1, var. **AMBOINENSIS** J. J. Sm. var. nov.

Plantae quam specimina javanica paulo robustiores. Labellum apice longius lacinulatum.

AMBOINA, Way tommo, *Reliquiae Robinsonianae 1638*, August 19, 1913, in sandy places on river banks, altitude 100 meters. Flowers pale-violet and white, the tip of the column brown.

The species has been recorded from Java and New Guinea. The variety collected in Amboina by Robinson differs chiefly in the longer toothed labellum.

ANOECTOCHILUS Blume

ANOECTOCHILUS REINWARDTII Blume Fl. Jav. Orch. (1858) 40, *t. 12, f. 2; t. 12b, f. 14.*

Folium petolatum II femina s. vera Rumph. Herb. Amb. 6: 93, *t. 41, f. 3.*

AMBOINA, Hitoe lama, *Robinson Pl. Rumph. Amb. 16*, November 5, 1913, from cultivated plants originating in the neighboring hills.

ANOECTOCHILUS ? sp.

AMBOINA, foothills of Mount Salahoetoe, *Robinson Pl. Rumph. Amb, 17*, November 27, 1913, sterile. Terrestrial, altitude 200 meters.

The leaves resemble those of the preceding species.

ZEUXINE Lindley

ZEUXINE AMBOINENSIS J. J. Sm. in Ic. Bog. 2 (1905) 259.

Folium petolatum mas Rumph. Herb. Amb. 6: *t. 41, f. 2* ?

AMBOINA, Way uri, *Reliquiae Robinsonianae 1916*, September 9, 1913, altitude 25 meters. Terrestrial in river bottoms.

Doctor Robinson describes the flowers as white; in the dried specimens the sepals are light green.

HETAERIA Blume

HETAERIA OBLONGIFOLIA Blume Bijdr. (1825) 410; Tabel. *f. 14.*

AMBOINA, Hitoe messen, *Reliquiae Robinsonianae 1629*, altitude 150 meters. Terrestrial on lime stone, the flowers white.

Not previously recorded from Amboina.

GOODYERA R. Brown

GOODYERA RUBICUNDA Lindl. in Bot. Reg. (1839) 92, var. **AMBOINENSIS** J. J. Sm. var. nov.

Caulis e basi decumbente radicante adscendens, validus, c. 10–foliatus, c. 47 cm longus. Folia petiolata, oblique elliptica ad oblanceolato-elliptica, triangulo-angustata, acuminata, acuta, basi sensim longe acuminata, curvinervia, costa media dorso prominente, oblique reticulato-venosa, sicco membranacea, c. 9–17.5 cm longa, 3.85–5 cm lata; petiolus canaliculatus, basi dilatatus, cum vagina tubulosa c. 5.5–7.5 cm longus. Inflorescentia erecta, elongata, laxe multiflora, pedunculo c. 31 cm longo, superne pubescenti, vaginulis c. 7 foliaceis basi tubulosis adpressis superne decrescentibus et in bracteas vergentibus donato, rachide l ngius glanduloso pubescenti, c. 25 cm longa. Bracteae ovato-lanceolatae, sensim longe acuminatae, concavae, pubescentes, 1-nerviae, ad c. 1.8 cm longae. Flores quaquaversi, patentes, deinde patentissimi, c. 1.25 cm lati, 0.73 cm longi, sepalis patentissimis, dorso glanduloso-pubescentibus. Sepalum dorsal erectum, ovato-oblongum, sensim angustatum, obtusum, concavum, 3-nervium, c. 0.65 cm longum, 0.26 cm latum. Sepala lateralia divaricata, oblique oblonga, dimidio superiore angustata, anguste obtusa et apice canaliculata, 3-nervia, c. 0.625–0.66 cm longa, 0.27–0.3 cm lata. Petala sepalo dorsali agglutinata, oblique spathulata, ex ungue lineari superne dilatato plus minusve abrupte in laminam rhombeam obtusam dilatata, 1-nervia, c. 0.65 cm longa, 0.17 cm lata. Labellum erectum, inferne marginibus gynostemio adpressum, valde ventricoso-concavum, subtus longitudinaliter sulcatum, basi lata oblique subsaccata affixum, apice abrupte contractum recurvumque, 5-nervium, explanatum suborbiculare, margine antico excepto carnoso-incrassatum et intus dense muricibus mollibus obtectum, apice abrupte in appendicem triangulo-oblongam obtusam contractum, totum c. 0.57 cm longum, 0.475 cm latum, appendice c. 0.15 cm longa. Gynostemium vix curvulum, clavatum, basi tenue et subtus longitudinaliter costatum, c. 0.5 cm longum, clinandrio magno, alte excavato, ovato, quam dimidium gynostemii breviore. Anthera erecta, basi in clinandrium immersa, oblongo-triangula, sensim acuminata, apice recurvula, acuta, basi truncata biloba, lobis

retusis, connectivo convexo, c. 0.26 cm longa. Rostellum porrectum, bifidum, laciniis anguste triangulis, subfalcatulis. Stigma clinandrio minus, margine recurvulum, basi truncatum. Ovarium sessile, glanduloso-pubescens, c. 0.775 cm longum.

AMBOINA, Mahija, *Reliquiae Robinsonianae 1615*, August 12, 1913. Terrestrial, altitude 150 meters. Flowers white and yellow.

This variety differs from Blume's description and figure in the longer and denser inflorescence with smaller and more spreading flowers, the more spathulate petals, broader lip with a shorter blunt apical lobe, and the shorter anther. The details of Blume's figure however need correction.

COELOGYNE Lindley

COELOGYNE RUMPHII Lindl. Fol. Orch. Coel. (1854) 14.

Angraecum nervosum Rumph. Herb. Amb. 6: 106, *t. 48.*

AMBOINA, Soja and Bato merah, *Robinson. Pl. Rumph. Amb. 7*, August 24 and 31, 1913, altitude 150 and 300 meters.

PLOCOGLOTTIS Blume

PLOCOGLOTTIS LOWII Reichb. f. in Gard. Chron. (1865) 434.

AMBOINA, Mount Salahoetoe, *Reliquiae Robinsonianae 1618*, November 27, 1913. On ridges, altitude 300 meters; the sepals greenish-lilac, the petals greenish.

CALANTHE R. Brown

CALANTHE VERATRIFOLIA R. Br. in Bot. Reg. 9 (1823) *t. 270.*

Flos triplicatus Rumph. Herb. Amb. 6: 115, *t. 52, f. 2.*

AMBOINA, Koesoekoesoe sereh, *Robinson Pl. Rumph. Amb. 10*, August 7 and 23, 1913. Terrestrial, altitude 200 meters; flowers white.

SPATHOGLOTTIS Blume

SPATHOGLOTTIS PLICATA Blume Bijdr. (1825) 401; Tabel. *f. 76.*

Angraecum terrestre primum purpureum Rumph. Herb. Amb. 6: 112 (excl. fig.).

AMBOINA, town of Amboina, Soja road, Batoe gadjah, and Hitoe messen, *Robinson Pl. Rumph. Amb. 15, Reliquiae Robinsonianae 1628*, July, August, and November, 1913. Terrestrial, altitude 10 to 150 meters.

This plant is not *Angraecum terrestre alterum* Rumph. Herb. Amb. 6: 113, *t. 50, f. 3*, but as I formerly pointed out (Orch. Amb. 25) is *Angraecum terrestre primum purpureum* Rumph.

MICROSTYLIS Nuttall

MICROSTYLIS ? VENTILABRUM Reichb. f. in Gard. Chron. 16 (1881) 717.

AMBOINA, Mahija, *Reliquiae Robinsonianae 1614*, August 7, 1913, altitude 250 meters. Terrestrial, in humus, the flowers yellow, turning brown, then red; fruit green; leaves purplish-green.

As Reichenbach's description of this species is insufficient, the identity of Robinson's specimen is not certain.

PSEUDERIA Schlechter

PSEUDERIA FOLIOSA Schltr. Orch. Deutsch Neue-Guinea (1912) 644.

Dendrobium foliosum Brongn. Bot. Voy. Coq. 203, *t. 41.*

AMBOINA, Gelala and Hoetoemoeri road, *Robinson Pl. Rumph. Amb. 18,* September 19 and 30, 1913, altitude 300 meters. Terrestrial and climbing on trees.

DENDROBIUM Swartz

DENDROBIUM PAPILIONIFERUM J. J. Sm. Orch. Amb. (1905) 42.

Angraecum crumenatum Rumph. Herb. Amb. 6: *t. 47, f. 2.*

AMBOINA, Wakal, *Robinson Pl. Rumph. Amb. 13,* November, 1913, on *Sonneratia* trees along the seashore. Flowers white, the tips of the sepals and petals pale-lilac; lip mainly white below the constriction, lilac beyond, the central thickening yellow on the margins, about 8 lilac veins on each side below the constriction, faint, branched, extending to the margin.

This plant is not, as Doctor Robinson suggested, *Angraecum album minus* Rumph. Herb. Amb. 6: 99, *t. 44, f. 1,* which has white flowers.

DENDROBIUM EPHEMERUM J. J. Sm. in Merr. Interpret. Herb. Amb. (1917) 174.

Dendrobium papilioniferum J. J. Sm. var. *ephemerum* J. J. Sm. Orch. Amb. (1905) 45.

Angraecum album minus Rumph. Herb. Amb. 6: 99, *t. 44, f. 1.*

AMBOINA, Hitoe lama, *Robinson Pl. Rumph. Amb. 19,* November 5, 1913, altitude 75 meters.

Robinson suggested that this specimen represented *Angraecum sextum moschatum* Rumph., but the Rumphian species is *Dendrobium rumphianum* T. & B.

DENDROBIUM MOLUCCENSE J. J. Sm. in Bull. Jard. Bot. Buit. 13 (1914) 11.

Dendrobium atropurpureum J. J. Sm. (nec Miq.) Orch. Amb. (1905) 54.

Herba supplex minor Rumph. Herb. Amb. 6: 110, *t. 50, f. 2.*

AMBOINA, Roemah tiga, *Robinson Pl. Rumph. Amb. 17,* July 20, 1913. On trees, usually *Calophyllum inophyllum,* at sea level, the flowers very dark red.

DENDROBIUM ACUMINATISSIMUM Lindl. Gen. et Sp. Orch. (1830) 86.

AMBOINA, Paso, *Reliquiae Robinsonianae 1622,* October 13, 1913, epiphytic, on trees near the beach.

The specimen may represent the var. *papuanum* J. J. Sm., but the flowers are withered.

DENDROBIUM CONSANGUINEUM sp. nov.

Rhizoma breve, repens, ramosum, radicibus crassis. Caules approximati, basi incrassati, foliati, c. 50 cm longi, internodiis ad c. 2 cm longis. Folia patentissima, oblongo-ovata, apicem versus angustata, valde oblique obtuse bidentata, basi rotundata,

carnosa, nervis sicco supra prominentibus, ad c. 4.75 cm longa, 1.9 cm lata (sicco); vaginae tubulosae, sicco prominenter nervosae, dense verruculosae, internodia aequantes. Inflorescentiae vaginam dorso ad basin perforantes, patentes, abbreviatae, 2-florae, pedunculo c. 0.6–0.8 cm longo, basi nonnullis vaginulis lateraliter compressis semioblongis rotundatis ad c. 0.2–0.3 cm longis cincto. Flores minusculi. Sepalum dorsale anguste oblongum, obtusum, breviter crasse obtuse conico-apiculatum, valde concavum, 1-nervium, laxe reticulatato-venosum, bene 1.2 cm longum, 0.35 cm latum. Sepala lateralia cum pede gynostemii mentum conicum obtusum cum ovario angulum acutum faciens formantia, antice basi brevissime connata, basi in laciniam oblique oblongum dilatata, oblongo-triangula, falcata, apice dorso incrassata, obtusa, concava, 3-nervia, costa media dorso incrassata, bene 1 cm longa, basi 0.8 cm, supra basin 0.43 cm lata. Petala lanceolata, falcata, anguste obtusa, dorso ad apicem incrassata, concava, 3-nervia, c. 0.97 cm longa, 0.225 cm lata. Labellum erectum, apice recurvum, concavum, simplex, spathulatum, 5-nervium, papillosum, explanatum c. 1.15 cm longum, ungue lineari, bicostato, lamina rhombea, apice contracta, obtusa, margine irregulariter sublaciniata, medio callifera, c. 0.35 cm lata. Gynostemium absque anthera c. 0.2 cm longum, apice triangulo, auriculis aequilongis, triangulis, subacutis, appendice lineari apice dilatata obtuse conduplicato-biloba fere 0.2 cm longa infra stigma. Anthera cucullata, basi biloba, apice late rotundato-truncata, antice convexa cum costula longitudinali, bene 0.1 cm lata. Pes gynostemii cum ovario angulum acutum faciens, rectus, linearis, c. 0.6 cm longus. Ovarium 6-sulcatum, cum pedicello c. 0.90 cm longum.

AMBOINA, Wakal, *Reliquiae Robinsonianae 1630, 1624*, November 5 1913, at sea level. Flowers in pairs, yellow, the sepals and petals within with lilac spots in lines; lip pure white; column whitish-lilac along the margin and near the apex.

This is a close ally of *Dendrobium insigne* Reichb. f., of new Guinea. I have retained it as a species because it is smaller in all its parts than is Reichenbach's species, and especially because the lip lacks the lateral lobes. It is, however, not impossible that it will eventually prove to be merely a variety of the widely distributed *Dendrobium insigne* Reichb. f., which is found at low altitudes in New Guinea and the neighboring islands.

DENDROBIUM PURPUREUM Roxb. Fl. Ind. ed. 2, 3 (1832) 484.

Angraecum purpureum silvestre Rumph. Herb. Amb. 6: 109, *t. 50, f. 1.*

AMBOINA, Wae, *Robinson Pl. Rumph. Amb. 5*, November 29, 1913, a pendant epiphyte, altitude about 20 meters. Flowers lilac, the sepals tipped with green.

DENDROBIUM LANCIFOLIUM A. Rich. Sert. Astrolab. (1834) 20, t. 8.

AMBOINA, Amahoesoe, *Reliquiae Robinsonianae 1637*, September 16, 1913, terrestrial, on hills and along dry water courses, altitude 70 to 150 meters. The tip of the lip and column is pink-lilac, the rest shading from pale lilac to pure white.

ERIA Lindley

ERIA BRACTESCENS Lindl. Bot. Reg. (1841) Misc. 18.

AMBOINA, Wakal, *Reliquiae Robinsonianae 1617*, November 5, 1913, on *Sonneratia* trees along the seashore.

It is not entirely certain that *Eria littoralis* T. & B. is conspecific with E. *bractescens* Lindl., as is generally accepted to be the case.

GRAMMATOPHYLLUM Blume

GRAMMATOPHYLLUM SCRIPTUM (Linn.) Blume Rumphia 4 (1847) 48.

Angraecum scriptum Rumph. Herb. Amb. 6: 95, *t. 42*.

AMBOINA, Paso, *Robinson Pl. Rumph. Amb. 6*, October 29, 1913. Epiphytic, altitude 10 meters; flowers green with purple blotches. Local name *manumpang*.

PHREATIA Lindley

PHREATIA ? POTAMOPHILA Schltr. in Fedde Repert. 10 (1911) 187.

AMBOINA, Roemah tiga, *Reliquiae Robinsonianae 1632*, July 20, 1913. Flowers pale-yellowish; fruit green.

The species is reported by Doctor Robinson as being quite common, but was apparently located just beyond the flowering season, as he found only one plant in flower, and a few with withered inflorescences.

The specimen is apparently the same as *Phreatia potamophila* Schltr., but I did not dissect the single flower, and I have not seen the type specimen of Schlechter's species.

APPENDICULA Blume

APPENDICULA REFLEXA Blume Bijdr. (1825) 301.

AMBOINA, Way tommo, *Reliquiae Robinsonianae 1636*, August 17, 1913, epiphytic, altitude 60 meters; flowers white.

Although Doctor Robinson described the flowers as white, there were no flowers on the specimen examined.

ACRIOPSIS Reinwardt

ACRIOPSIS JAVANICA Reinw. in Flora Lit. 2: 4.

AMBOINA, Hitoe messen, *Reliquiae Robinsonianae 1623*, November 1, 1913, epiphytic, altitude 150 meters. Sepals yellowish, violet along the middle; lip white, lilac in the center.

SARCOCHILUS R. Brown

SARCOCHILUS ZOLLINGERI Reichb. f. in Walp. Ann. 6 (1861) 500.

AMBOINA, Lateri, *Reliquiae Robinsonianae 1633*, August, 25, 1913, epiphytic, altitude 200 meters; flowers yellow.

THRIXSPERMUM Loureiro

THRIXSPERMUM AMPLEXICAULE Reichb. f. Xen. Orch. 2: 121.

AMBOINA, Koesoekoesoe sereh and Batoe merah, *Reliquiae Robinsonianae 1635*, August 23 and 24, 1913, terrestrial, altitude 80 meters; flowers white, with a very pale tinge of violet, at first erect, then spreading, the column with a yellow ring on the inside and a yellow spot below it.

SACCOLABIUM Blume

SACCOLABIUM RUMPHII J. J. Sm. in Bull. Jard. Bot. Buit. 13 (1914) 44.

AMBOINA, Roemah tiga, *Reliquiae Robinsonianae 1634*, July 20, 1913. Epiphytic, usually on *Calophyllum inophyllum* at sea level. Flowers yellow at the base, white toward the apex.

PHALAENOPSIS Blume

PHALAENOPSIS AMABILIS (Linn.) Blume Bijdr. (1825) 295; Tabel *f. 44.*

Angraecum album majus Rumph. Herb. Amb. 6: 99, *t. 43.*

AMBOINA, Amahoesoe, *Robinson Pl. Rumph. Amb. 8*, August 30, 1913, epiphytic, altitude 4 to 8 meters. Flowers white, callosities on the lip with yellow margins and lilac dots.

PHALAENOPSIS ROBINSONII sp. nov.

Caulis brevis, c. 5-folius, radicibus numerosis. Folia anguste oblique oblonga, obtusa, basin versus sensim angustata, ima basi conduplicata, costa media dorso (sicco) leviter prominente, sicco ad c. 31 cm longa, 5.7 cm lata; vaginae basi tubulosae, ceterum conduplicatae, c. 1.5–2 cm longae. Inflorescentiae foliis breviores, ramosae, pedunculo usque ad rachidem terminalem c. 19.5 cm longo, vaginulis paucis parvis patentibus carinatis donato, rachide diu flores gignente, fractiflexa, c. 3.75 cm vel plus longa, internodiis 0.25–1 cm longis. Bracteae alternatim bifariae, patentes vel patentissimae, conduplicatae, curvatae, concavae, acutae, carinatae, sicco 0.45–0.5 cm longae. Flores intervallis circa terni aperti, mediocres. Sepalum dorsale oblongum, apice marginibus incurvis contiguisque contractum, obtusum, concavum, 7-nervium, carnosum, c. 1.5 cm longum, 0.6 cm latum. Sepala lateralia oblique lanceolata, apice incurvo acuminata, acuta et dorso carinata, concava, 7-nervia, carnosa, c. 1.7 cm longa, 0.55 cm lata. Petala oblique elliptica, obtusa, acute et crasse conico-apiculata, basi satis angusta, concava, 5-nervia, c. 1.4 cm longa, 0.65 cm lata. Labellum porrectum, glabrum basi lamella brevi longitudinali horizontali adpressa antice bidentata dorso obtusangula donatum, appendice longitudinali adnata angusta carnosa lateraliter compressa supra canalicula crenulato-bicostata antice libera horizontali bisubulata usque ad c. 0.6 cm supra basin pertinente ante lamellam basilarem, explanatum c. 1.25 cm longum, ad lobos laterales 0.6 cm latum; lobi

laterales breves, erecti, basilares, trianguli, obtusangule falcato-recurvi, fere quadranguli, acuti, extus concavuli, intus medio prope marginem anticum callo brevi verticali erecto rotundato carnoso ornati, c. 0.25 cm longi, basi fere 0.3 cm lati; lobus intermedius porrectus, elliptico-spathulatus, longius unguiculatus, apice contractus, obtusus, costa valida longitudinali carnosa convexa dimidio superiore magis elevata usque in apicem, glaber, carnosus, c. 0.87 cm longus, explanatus 0.375 cm latus. Gynostemium rectum, basi subtus contractum, c. 1 cm longum, apice producto triangulo, obtuso, c. 0.27 cm longo. Anthera magna, cucullata, antice alte obtusangule bilamellata, lateraliter visa oblique quadrangula, c. 0.43 cm longa. Rostellum reversum, bidentatum. Stigma maximum, alte excavatum. Ovarium pedicellatum, 6-sulcatum, c. 1.1 cm longum.

AMBOINA, Hitoe messen, *Reliquiae Robinsonianae 1627*, October 18, 1913, on trees, altitude 600 meters. Flowers white with lilac spots.

A few years ago but one species of *Phalaenopsis* was known from Amboina, the widely distributed *Ph. amabilis* Bl. In 1911 *Ph. amboinensis* J. J. Sm. was described from Amboina and Ceram and in the next year Finet published his *Ph. Hombronii*. One year later the unfortunate and lamented Doctor Robinson discovered two more species, the one above described, and *Ph. Hebe* Reichb. f.

Phalaenopsis amboinensis J. J. Sm., *Ph. Hombronii* Finet, and *Ph. Robinsonii* J. J. Sm. are closely allied species with hairless lips. *Ph. amboinensis* has the largest flowers, which, however, so far as I know, are borne in only 1- or 2-flowered scapes, while in the other two the inflorescences are branched and with more numerous flowers. In *Ph. amboinensis* and *Ph. Hombronii* the midlobe of the lip is provided with a conspicuous longitudinal denticulated keel, which is lacking in *Ph. Robinsonii*.

The three species may be distinguished as follows:

1. Midlobe of lip with a broad, longitudinal, smooth ridge. Sepals oblong. Column foot very short. Inflorescence branched. *Ph. Robinsonii* J. J. Sm.
   Midlobe of lip with a conspicuous denticulated keel. Column foot distinct ..... 2.
2. Sepals ovate, 2.5 cm. long, 1.3 cm. and 1.47 cm. broad. Lip 1.9 cm long. Inflorescence unbranched..... *Ph. amboinensis* J. J. Sm.
   Dorsal sepal lanceolate, 1.4 cm long, 0.8 cm broad. Lip 1.8 cm long. Inflorescence branched ..... *Ph. Hombronii* Finet.

PHALAENOPSIS HEBE Reichb. f. in Hamb. Gartenz. 18 (1862) 85.

AMBOINA, Koeda mati, *Reliquiae Robinsonianae 1620*, September 3, 1913, epiphytic, altitude 15 meters. Flowers white, turning yellow when old, the base of the sepals with a band of brown dots inside, the lip and column mainly mauve purple, the tip of the lip white. Local name *vanil manumpang*.

The flowers seem to differ a little in color from the Javanese and Sumatran specimens. The Amboina form might perhaps be distinguished as var. **AMBOINENSIS.**

LUISIA Gaudichaud

LUISIA CONFUSA Reichb. f. in Walp. Ann. 6 (1861) 621.

Luisia teretifolia Blume Rumphia 4 (1848) *t. 194, f. 3; t. 197D.*
Angraecum flavum decimum sive angustifolium Rumph. Herb. Amb. 6: 104.

AMBOINA, Paso, *Reliquiae Robinsonianae 1626*, July 20, 1913, epiphytic, altitude 2 meters. Flowers yellowish-green, but the lip, except for the yellow margin, lilac-purple.

I have no doubt that this form is Rumphius's *Angraecum flavum decimum sive angustifolium*, although he states that the leaves are not rounded but flat; I suppose that he intended to say the contrary.

RENANTHERA Loureiro

RENANTHERA MOLUCCANA Blume Rumphia 4 (1848) 54, *t. 193, f. 2; t. 197E.*

Angraecum rubrum Rumph. Herb. Amb. 6: 101, *t. 44, f. 2.*

AMBOINA, Soja, *Robinson Pl. Rumph. Amb. 20*, September 27, 1913. Flowers spotted all over with red, apex of the column white. Native names *bunga karang* and *manumpang karang*.

ROBIQUETIA Gaudichaud

ROBIQUETIA AMBOINENSIS J. J. Sm. in Nat. Tijdschr. Nederl. Ind. 72 (1912) 43.

AMBOINA, Wae, *Reliquiae Robinsonianae 1621*, November 29, 1913, epiphytic, altitude 20 meters. Flowers yellowish.

TAENIOPHYLLUM Blume

TAENIOPHYLLUM MINUTIFLORUM sp. nov.

Caulis abbreviatus, squamis subulatis, radicibus elongatis, angustis, compressis, ad c. 30 cm longis, sicco 0.16 cm latis. Inflorescentiae numerosae, diu florentes, dense multiflorae, pedunculo filiformi, c. 1.2–4 cm longo, vaginulis 2 parvis basi tubulosis carinatis donato, rachide tenui, ad c. 1.35 cm longa, cum bracteis c. 0.125 cm lata, internodiis vix c. 0.03 cm longis. Bracteae alternatim bifariae, patentes, rachidem amplectentes, late triangulae, obtusae, concavae, carinatae, dorso c. 0.05 cm longae. Flores succedanei, parvi, c. 0.16 cm longi. Sepalum dorsale oblongo-ovatum, subobtusum, concavum, 1-nervium, bene 0.1 cm longum. Sepala lateralia oblique lanceolato-triangula, acuta, concava, apice vix incurvula, carinata, 1-nervia, bene 0.1 cm longa. Petala lanceolato-ovata, acuta, concava, 1-nervia, c. 0.1 cm longa. Labellum concavum, subtrilobum, gynostemio duplo longius, explanatum transverse subrhombeum, triangulo-oblongo-contractum, cum calcari cruciforme, totum c. 0.175 cm, absque calcari 0.1 cm longum, 0.1 cm latum; lobi laterales erecti, gynos-

temio adpressi, semiorbiculari-trianguli, obtusissimi, concavi; lobus intermedius porrectus, oblongus, obtusus, lateraliter compressus, basi tantum concavus, carnosus; calcar reversum, cum ovario angulum acutum faciens, laminam continuum, rectum, oblongum, obtusum, c. 0.075 cm longum. Gynostemium breve, obtusum, c. 0.03 cm longum. Anthera cucullata, in rostrum elongatum oblongum spurie retusum contracta. Rostellum elongatum, infra medium incurvum, antherae parallelum, basi postice triangulo-productum. Ovarium pedicellatum c. 0.1 cm longum. Capsula immatura elongata, 1.3 cm longa, pedicello 0.17 cm longo.

AMBOINA, Hitoe messen, *Reliquiae Robinsonianae 1631*, October 10, 1913, epiphytic, altitude 150 meters. Flowers yellow-green.

This is allied to *Taeniophyllum filiforme* J. J. Sm., but the flowers are smaller and the spur is not inflated.

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NEW PHILIPPINE SHRUBS AND TREES

By E. D. MERRILL [1]

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The present paper consists for the most part of the descriptions of forty-five presumably new species of Philippine trees and shrubs, in the families *Chloranthaceae, Myristicaceae, Saxifragaceae, Cunoniaceae, Leguminosae, Rutaceae, Simarubaceae, Sabiaceae, Sapindaceae, Celastraceae, Elaeocarpaceae, Gonystylaceae, Guttiferae, Combretaceae, Myrtaceae, Symplocaceae, Ericaceae, Ebenaceae, Loganiaceae, Thymelaeaceae,* and *Verbenaceae.* A few changes in nomenclature are included. The genera *Elaeodendron* and *Pleurostylia* are here recorded from the Philippines for the first time, and the new genus *Trifidacanthus* is proposed and described in the *Leguminosae.*

Two characteristic new species of *Xanthostemon* are noteworthy, as are two new species of *Symplocos* with 3-partite calyces, a character hitherto unrecorded for the *Symplocaceae.* The southeastern element in the Philippine flora is emphasized not only by the two additional species of *Xanthostemon,* but by the discovery of a second species of *Ascarina* in the Philippines. The Philippine form of *Pleurostylia* is apparently identical with a New Calendonian variety of *P. wightii* W. & A. The widely distributed *Vaccinium* commonly known as *V. villarii* Vid. is reduced to the Moluccan *V. myrtoides* Miq. The continental element in flora is emphasized by the discovery of *Englehardtia colebrookeana* Lindl. in northern Luzon.

CHLORANTHACEAE

ASCARINA Forster

ASCARINA RETICULATA sp. nov.

Arbor circiter 8 m alta, glabra; foliis oblongo-ellipticis ad oblongo-obovatis, coriaceis, utrinque distincte reticulatis, in siccitate brunneis, usque ad 9 cm longis, obtuse acuminatis, basi acutis, margine crenatis vel serrulato-crenatis; nervis primariis utrinque circiter 15 cum venularum reti utrinque conspicuo; pani-

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culis terminalibus, solitariis, sessilibus vel breviter pedunculatis, 2 ad 2.5 cm longis, bracteis ovatis, subacutis, circiter 2.5 mm longis, deciduis; fructibus ellipsoideis, 3 mm longis, spicatim dispositis.

A glabrous tree about 8 m high, all parts dark-brown when dry, the branchlets smooth. Leaves oblong-elliptic to oblong-obovate, rather thickly coriaceous, somewhat shining, of the same color on both surfaces, 6 to 9 cm long, 2.5 to 4 cm wide, subequally narrowed to the obtusely acuminate apex and to the acute base, the margins crenate or serrulate-crenate, the basal 1 to 2 mm entire; lateral nerves slender, distinct, about 15 on each side of the midrib, these equally prominent on both surfaces and about as distinct as the secondary nerves and reticulations; petioles 5 to 8 mm long. Panicles terminal, sessile or shortly peduncled, usually branched from the base, 2 to 2.5 cm long, the spike-like branches about 1 cm long; bracts deciduous, ovate, subacute, coriaceous, about 2.5 mm long. Fruits brown, ellipsoid, 3 mm long, numerous, sessile, subtended by a disk-like enlargment of the rachis about 1.5 mm in diameter, tipped by the conspicuous stigma.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26399 Ramos & Edaño*, August 19, 1916, in forests, altitude about 400 meters, locally known as *parukanak*.

A species allied to *Ascarina philippinensis* C. B. Rob., from which it is distinguished by its coriaceous leaves, much more numerous nerves which, with the secondary nerves and reticulations are conspicuous on both surfaces; all parts, stems, branches, leaves, and inflorescences brown when dry; its crenate rather than serrate leaves; and its shorter, deciduous or caducous bracts. The second species of this characteristic Polynesian genus to be found in the Philippines.

JUGLANDACEAE

ENGLEHARDTIA Leschenault

ENGLEHARDTIA COLEBROOKEANA Lindl. in Wall. Pl. As. Rar. 3 (1832) 4, *t. 208*.

LUZON, Ilocos Sur Province, Kirsudan, *For. Bur. 25483 Paraiso*, March 25, 1916, on slopes, altitude about 300 meters, locally known as *pedped*.

The specimen agrees closely with the descriptions and with Indian specimens of this species and I consider it certainly to represent Lindley's species. An older name is perhaps *Englehardtia villosa* (Wall.) Kurz, based in *Juglans villosa* Wall. Cat. (1831, or 1832) no. 4945, but Wallich's name is a *nomen nudum* and has no standing. The species has not previously been reported from the Philippines.

India to Burma and southern China.

MYRISTICACEAE

GYMNACRANTHERA Warburg

GYMNACRANTHERA ACUMINATA sp. nov.

Arbor circiter 11 m alta, inflorescentiis ferrugineo-pubescentibus exceptis glabra; foliis oblongis ad anguste oblongo-ovatis, usque ad 11 cm longis, apice tenuiter subcaudato-acuminatis, basi cuneatis, subcoriaceis, in siccitate brunneis, supra perspicue nitidis, nervis utrinque 5 vel 6, subtus distinctis, curvato-adscendentibus; paniculis axillaribus, multifloris, leviter adpresse ferrugineo-pubescentibus, 3 ad 4 cm longis; floribus ♂ numerosis, 4 mm longis, usque ad medium 3- vel 4-partitis, antheris in massam cylindraceam 1.7 ad 2 mm longam connatis.

A tree about 11 m high, glabrous except the inflorescences. Branches terete, grayish-brown, lenticellate. Leaves subcoriaceous, brown when dry, the upper surface very prominently shining, the lower dull, oblong to narrowly oblong-ovate, 9 to 11 cm long, 3 to 3.5 cm wide, narrowed upward to the prominently caudate-acuminate apex and below to the cuneate base, the acumen slender, about 1.5 cm long, blunt; primary lateral nerves 5 or 6 on each side of the midrib, prominent on the lower surface, curved-ascending, anastomosing, the reticulations very lax, obscuré; petioles slender, 1 to 1.4 cm long. Staminate panicles axillary, numerous, 3 to 4 cm long, many-flowered, appressed-pubescent with scattered ferruginous hairs, the flowers racemose-fascicled on the ultimate branchlets. Buds ellipsoid, the mature flowers oblong, 4 mm long, divided to about the middle into 3 or 4, ovate, obtuse lobes, externally sparingly pubescent. Staminal column cylindric, 1.7 to 2 mm long.

SAMAR, Dolores, *For. Bur. 21074 Sherfesee, Cenabre, & Cortes*, April 5, 1914, in forested flats, altitude 15 meters, locally known as *daha-an*

The specimen was originally identified as *Gymnacranthera paniculata* Warb., and while it represents a species allied to the latter, it is readily distinguised among all the Philippine forms by its prominently shining, brown, few-nerved caudate-acuminate leaves. The staminate flowers are rather large for *Gymnacranthera*.

HORSFIELDIA Willdenow

HORSEFIELDIA OBSCURINERVIA sp. nov.

Arbor glabra circiter 11 m alta; foliis oblongis ad oblongo-lanceolatis, coriaceis, usque ad 14 cm longis, utrinque subaequaliter angustatis, acuminatis, basi cuneatis, in siccitate brunneis, nervis utrinque circiter 18, tenuibus, obscuris, haud anastomosantibus, secondariis reticulisque obsoletis; paniculis axillaribus, cir-

citer 6 cm longis, multifloris; floribus ♂ obovoideis, 2 mm longis, 2-lobatis, antheris in massam obovoideam apice depressam 1.5 mm longam connatis.

A glabrous tree about 11 m high, or the very youngest branchlets and the midrib beneath sparingly ferruginous-pubescent. Branches terete, dark-brown, lenticellate. Leaves oblong-lanceolate, 11 to 14 cm long, 3 to 4 cm wide, coriaceous, brown and slightly shining when dry and of nearly the same color on both surfaces, subequally narrowed to the rather prominently acuminate apex, the acumen blunt, and to the cuneate base, the margins recurved; lateral nerves about 18 on each side of the midrib, very slender, obscure, not anastomosing, the secondary ones and reticulations obsolete, the primary nerves very slightly impressed in the median portion on the upper surface, the midrib prominent beneath; petioles 1 to 1.5 cm long. Staminate panicles axillary, about 6 cm long, glabrous, the flowers subracemosely arranged on the short ultimate branchlets. Staminate flowers yellow when fresh, brown when dry, obovoid, 2 mm long, 2-valved, their pedicels 1 to 1.5 mm long. Staminal column obovoid, 1.5 mm long, depressed at the apex.

LUZON, Camarines Province, Paracale, *For. Bur. 26503 de Mesa & Magistrado*, July 26, 1916, on low hills, altitude about 20 meters, locally known as *duguan*.

This rather strongly marked species is well characterized by its relatively narrow, very obscurely nerved leaves. The staminate inflorescences strongly resemble those of *Gymnacranthera paniculata* Warb., but the species is a true *Horsfieldia*.

SAXIFRAGACEAE

DEUTZIA Thunberg

DEUTZIA ACUMINATA sp. nov.

Species *D. pulchrae* Vid. affinis, differt foliis majoribus, usque ad 12 cm longis, nervis utrinque magis numerosis, utrinque circiter 8.

A shrub, all parts more or less white stellate-lepidote. Branches and branchlets terete, reddish-brown, smooth, the latter minutely stellate-lepidote. Leaves lanceolate to oblong-lanceolate, subcoriaceous, brittle, pale-brownish when dry, the lower surface grayish-white or at least paler than the upper surface, 8 to 12 cm long, 3 to 5 cm wide, gradually narrowed upward to the slenderly acuminate apex, the base rounded, margins distantly denticulate, both surfaces with minute, white stellate-lepidote scales, these widely scattered on the upper surface, rather densely

arranged on the lower surface; lateral nerves about 8 on each side of the midrib, prominent on the lower surface, curved, anastomosing, the reticulations lax; petioles 1 to 1.5 cm long. Panicles terminal, narrow, up to 8 cm in length, the lower branches 2 cm long or less, all parts sparingly stellate-lepidote. Fruits cup-shaped, truncate, gray stellate-lepidote, about 5 mm long, 6 mm in diameter, the styles exserted about 5 mm.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26441 Ramos & Edaño*, August 14, 1916, in forests, altitude about 300 meters.

A species manifestly allied to *Deutzia pulchra* Vid., its much larger, more numerously nerved leaves giving it an aspect quite different from the typical form of Vidal's species.

HYDRANGEA Gronovius

HYDRANGEA PUBIRAMEA sp. nov.

Frutex circiter 2 m altus, ramis et inflorescentiis et petiolis et subtus foliis ad costa nervisque pilosis; foliis chartaceis, oblongis ad oblongo-obovatis, acute acuminatis, basi acutis, margine sursum denticulatis, nervis utrinque 5 vel 6, curvato-adscendentibus, subtus in siccitate plus minusve pustulosis; inflorescentiis terminalibus, pedunculatis, ramis primariis radiatis; fructibus junioribus ovoideis, glabris, stylis 3, crassis, curvatis, 2 ad 2.5 mm longis.

A shrub about 2 m high, the young branches, petioles, inflorescences, and leaves on the midrib and lateral nerves beneath pilose with somewhat appressed, pale-brownish hairs. Branches terete, grayish-brown. Leaves chartaceous, oblong to oblong-obovate, grayish-olivaceous when dry, slightly shining, 6 to 11 cm long, 3 to 4 cm wide, apex acutely acuminate, base acute, margins in the upper one-half denticulate, the teeth small, scattered, the lower surface pale-brownish, pustulate when dry; lateral nerves 5 or 6 on each side of the midrib, curved-ascending, anastomosing; petioles 1.5 to 2 cm long. Inflorescences terminal, peduncled, pubescent, the peduncles 5 to 20 mm long, the branches radiate, up to 4 cm long, flower-bearing only toward their apices, the pedicels about 5 mm long. Calyx-tube in fruit cuneate, 2 mm long, the lobes 5, oblong, 1 mm long. Capsule above the calyx-tube ovoid or globose, about 3 mm in diameter; styles 3, rarely 4, stout, curved, 2 to 2.5 mm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26521 Ramos & Edaño*, September 8, 1916, in forests, altitude about 300 meters.

A species similar and manifestly allied to *Hydrangea lobbiana* Maxim., from which it is readily distinguished by its indumentum.

Var. **PARVIFOLIA** var. nov.

A typo differt foliis minoribus, 4 ad 6 cm longis, haud pustulatis, petiolis brevioribus.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26511 Ramos & Edaño*, September 6, 1916, in forests, àltitude about 240 meters.

This is apparently but a reduced form of *Hydrangea pubiramea*, having smaller leaves and panicles and shorter petioles.

CUNONIACEAE

WEINMANNIA Linnaeus

WEINMANNIA SIMPLICIFOLIA sp. nov.

Frutex circiter 3 m altus, inflorescentiis leviter pubescentibus exceptis glaber; foliis crasse coriaceis, oblongo-ellipticis, usque ad 9 cm longis, in siccitate brunneis, nitidis, utrinque subaequaliter angustatis, apice obtusis, acutis, vel leviter acuminatis, basi plus minusve acuminatis, nervis primariis utrinque circiter 9, venularum reti denso, utrinque conspicuo; racemis numerosis, usque ad 9 cm longis; capsulis anguste ovoideis, circiter 3 mm longis, pubescentibus.

A shrub about 3 m high, glabrous except the inflorescence. Branches terete, brownish, the branchlets smooth, dark-brown, somewhat compressed at the nodes. Leaves simple, opposite, thickly coriaceous, brown and somewhat shining when dry, oblong-elliptic, 4.5 to 9 cm long, 2 to 3.5 cm wide, subequally narrowed to the obtuse, acute, or somewhat acuminate apex, and to the acuminate base, the margins crenate-serrate; primary lateral nerves about 9 on each side of the midrib, these and the prominent, rather close reticulations distinct on both surfaces; petioles 5 to 8 mm long. Inflorescence terminal, simple, or the rachis slightly branched, the peduncles and branches 1 cm long or less, the racemes numerous, fascicled at the tips of the branches or of the peduncle, up to 9 cm long, more or less pubescent with short, brownish hairs. Fruits numerous, fascicled at the nodes of the branches, their pedicels slender, somewhat pubescent, about 2 mm long, the capsules narrowly ovoid, about 3 mm long, brownish-pubescent, tipped by the styles, the latter about 1.5 mm long.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26531 Ramos & Edaño*, September 9, 1916, in forests, altutude about 300 meters.

A characteristic species allied to *Weinmannia luzonensis* Vid., but readily distinguished by its simple, thickly coriaceous, prominently nerved and reticulated leaves.

LEGUMINOSAE

TRIFIDACANTHUS Merrill genus novum

(*Papilionatae-Hedysareae-?Desmodiinae*)

Calycis membranacei, tubus brevis; lobi 2 superiores omnino connati vel apice minute 2-dentatae, 3 inferiores ovato-lanceolati, acuminati. Vexillum late obovatum, basi cuneatum, sessile vel subsessile; alae oblongae, obtusae; carina leviter falcata, obtusa. Stamen vexillare a basi libera, caetera connata; antherae uniformes. Ovarium breviter stipitatum, lineare, circiter 6-ovulatum; stylus leviter incurvus, glaber, stigmate minute terminali. Legumen * * *. Frutex parvus, erectus, subglaber, spinis longis rectis sparsis trifidis armatae. Folia 1-foliolata, foliolis minute stipellatis, ellipticis ad oblongo-ellipticis, integris, breviter petiolatis. Stipulae striatae, siccae, liberae. Flores purpurei, mediocri, racemosi, racemis axillaribus, brevibus, solitariis, paucifloris. Bracteae late ovatae, striatae, parvae; bracteolae 0.

TRIFIDACANTHUS UNIFOLIOLATUS sp. nov.

Frutex erectus, 1 ad 2 m altus, ramis numerosis, rigidis, teretibus; foliis alternis, breviter petiolatis, foliolis ellipticis ad oblongo-ellipticis, utrinque rotundatis, apice minutissime apiculatis, in siccitate pallidis, nitidis, 1.5 ad 3 cm longis; spinis sparsis, rectis, rigidis, tenuibus, trifidis, 8 ad 17 mm longis; racemis axillaribus, solitariis, paucifloris, leviter pubescentibus, circiter 3 cm longis; floribus circiter 1 cm longis.

An erect, much-branched, nearly glabrous shrub 1 to 2 m high, the branches stiff, terete, grayish, rugose when dry, scarcely lenticellate, the wood pale-yellowish, some of the nodes armed with stiff, slender, straight, sharp, trifid spines, their branches 8 to 17 mm long. Leaves numerous, alternate, 1-foliolate, their petioles 2 to 4 mm long, minutely bistipellate at the base of the very short, geniculate petiolule; blades elliptic to oblong-elliptic, equilateral, entire, subcoriaceous, equally rounded at both ends, the apex minutely apiculate, 1.5 to 3 cm long, 7 to 15 mm wide, pale and shining when dry, the lower surface often slightly glaucous, glabrous, or when young minutely puberulent; lateral nerves 6 to 8 on each side of the midrib, slender, anastomosing, not prominent, the reticulations distinct under a lens, rather close; stipules dry, striate, ovate-lanceolate, 1.5 to 2 mm long, acuminate. Racemes axillary, solitary, slender, few-flowered, about 3 cm long, sparingly pubescent, subtended by numerous, somewhat distichous, imbricate bracts similar to

the stipules, the pedicels about 5 mm long, the bracts subtending the pedicels ovate, acuminate, striate, 1.5 mm long. Flowers about 1 cm long, purplish. Calyx sparingly pubescent, membranaceous, 3 mm long, the upper two teeth usually wholly united into a 2-nerved, triangular-ovate, acute to obtuse, 1.2 mm long lobe, sometimes 2-dentate at the tip, the lower three teeth subequal, 1-nerved, ovate-lanceolate, acuminate, about 1 mm long. Petals glabrous, the standard broadly obovate, rounded or somewhat retuse, sessile or with a very short claw, base cuneate, about 9 mm long and 8 mm wide. Wings oblong, slightly inequilateral, free or nearly so, rounded, about 10 mm long and 3.5 mm wide, the claw 1.2 mm long, basal lobe rounded. Keel petals about 8 mm long and 3 mm wide, slightly falcate, oblong-obovate, rounded, the claw as long as that of the wings. Vexillary filament free from the base, the other nine united into a tube, the free parts of the filaments 1 to 1.5 mm long, all fertile, the anthers uniform. Ovary on a 1 mm long stipe, linear, slightly pubescent, about 4 mm long; ovules about 6; style curved, glabrous, about 3 mm long, the stigma minute. Fruit unknown.

LUZON, Ilocos Norte Province, Burgos, *Bur. Sci. 27196 Ramos*, March 3, 1917, in dry thickets at low altitudes.

I have placed this proposed new genus in the *Papilionatae-Hedysareae*, and with doubt in the *Desmodiinae*, as the fruits are unknown. It is strongly characterized by its long, straight, trifid, rigid spines and its 1-foliolate, shortly petioled leaves, the leaflet being minutely stipellate and elliptic or oblong-elliptic in shape. It does not appear to be closely allied to any previously described genus either in the group in which it is placed, or in other groups of the *Papilionatae*, although in some respects it is suggestive of the New Caledonian genus *Arthroclianthus* Baill. It is, however, radically different from Baillon's genus in general appearance, vegetative characters, floral characters, and in its trifid spines.

SOPHORA Linnaeus

SOPHORA LONGIPES sp. nov.

Frutex, partibus junioribus minute et parce adpresse pubescentibus; foliis usque ad 17 cm longis, foliolis circiter 15, ovato-ellipticis, in siccitate pallidis, glabris, usque ad 2.5 cm longis, obtusis; racemis axillaribus, foliis subaequantibus; floribus paucis, violaceis, circiter 13 mm longis; fructibus circiter 4 cm longis, longissime stipitatis, cylindraceis vel leviter compressis, haud moniliformibus, apice longe rostratis; seminibus solitariis.

A shrub, the younger branchlets, petioles, and inflorescences minutely pubescent with short appressed hairs; leaves about 17 cm long, somewhat crowded at the apices of the branches; leaflets

usually 15, ovate-elliptic, 2 to 2.5 cm long, 1 to 1.4 cm wide, pale when dry, glabrous, chartaceous, base rounded, apex obtuse, the nerves indistinct; petiolules 1 to 2 mm long, slightly pubescent. Racemes axillary, peduncled, about as long as the leaves, rather few-flowered, the pedicels slightly pubescent, about 7 mm long. Flowers violet, 13 mm long. Calyx cup-shaped, 8 mm long, obscurely 2-lipped, the teeth broad, short, the base rounded, inflated on the upper side, subglabrous. Standard 13 mm long, the claw elongated, the limb obovate, truncate-rounded, about 6 mm wide above; keel-petals with claws about 4.5 mm long, their limbs broadly oblong, 7 mm long, 4 mm wide, slightly falcate, apiculate on the outer side, rounded on the inner; wings with claws about 5 mm long, their limbs narrowly oblong, rounded, about 9 mm long, 2 to 2.5 mm wide. Stamens united in the lower 2 mm. Ovary stipitate; ovules about 6. Fruits about 4 cm long, minutely pubescent, the stipe slender, curved, about 2 cm long, the inflated part cylindric or slightly compressed, tipped with a somewhat curved beak less than 1 cm in length; seeds solitary.

LUZON, Batangas Province, on dry slopes between Bauang and Punta de Azufre, *Bur. Sci. 26765 Ramos*, October 20, 1916.

The specimens were from flowering branches taken from old trunks or roots in a deserted clearing, so that the size of the plant is uncertain; it is probably merely a shrub or at most a small tree. It is well characterized by its one-seeded, rostrate-acuminate, long-stipitate pods. It is entirely different from the other two species found in the Philippines.

PTEROCARPUS Linnaeus

PTEROCARPUS PUBESCENS sp. nov.

Arbor alta, omnibus partibus dense molliter pubescentibus, indumento brunneo; foliis circiter 20 cm longis, foliolis usque ad 11, oblongis ad oblongo-ovatis, obtuse acuminatis, usque ad 7 cm longis, nervis utrinque circiter 9, tenuibus; fructibus suborbicularibus, 4 ad 5.5 cm diametro, brunneo-pubescentibus, medio tenuiter spinoso-echinatis, spinis 2 ad 4 mm longis.

A tree variable in size, from 8 to 20 m in height, all parts prominently and densely pubescent with rather soft, brown hairs. Older branches glabrous, reddish-brown, terete, the younger ones densely pubescent. Leaves about 20 cm long, rachis, petioles, and petiolules very densely pubescent, the leaflets more or less pubescent on both surfaces, often densely so; leaflets up to 11, oblong-ovate to oblong, up to 7 cm long, 2.5 to 3.5 cm wide, firmly chartaceous, brownish when dry, somewhat shining, blunt-acuminate, or the acumen sometimes apiculate, base rounded; lateral nerves about 9 on each side of the midrib,

slender. Inflorescences reduced to simple, axillary, solitary racemes up to 15 cm in length, the rachis, pedicels, and calyces densely pubescent. Flowers yellow, their pedicels up to 1 cm in length. Calyx about 8 mm long. Standard about 1.4 cm long, the claw stout, 4 mm long, cuneate, the limb 8 to 9 mm wide; wings inequilateral, their claws slender, 4.5 mm long, their limbs oblong, 9 mm long; keel-petals 10 mm long, very inequilateral at the base. Staminal tube split down one side, all filaments united. Ovary densely pubescent. Fruit orbicular or suborbicular, brown, thin, 4 to 5.5 cm in diameter, more or less pubescent, base inequilateral, the central 2.5 cm with numerous, slender, straight, 2 to 4 mm long spines.

LUZON, Bontoc Subprovince, Bauco, *Vanoverbergh 3959* (type), February 1915, altitude about 1,300 meters, locally known as *narra:* Lepanto Subprovince, Cervantes, *Sandkuhl 286,* February 7, 1915.

A species manifestly allied to *Pterocarpus echinatus* Pers. (*P. vidalianus* Rolfe), but at once distinguished by its very dense indumentum, *P. echinatus* Pers. being glabrous.

CYNOMETRA Linnaeus

CYNOMETRA BIFOLIOLATA sp. nov.

Arbor glabra, ramis tenuibus, teretibus, lenticellatis; foliis bifoliolatis, foliolis oblongis ad oblongo-ellipticis, leviter inaequilateralibus, obtusis, basi acutis, subcoriaceis, nitidis, usque ad 10 cm longis, nervis primariis utrinque circiter 10, tenuibus; petiolulis 5 ad 8 mm longis; racemis axillaribus, fasciculatis, confertis, haud 1 cm longis, multifloris, bracteis reniformibus, striatis, circiter 2 mm longis; ovario glabro vel leviter pubescente; staminibus 10.

A glabrous tree attaining a height of about 10 m, the branches slender, terete, lenticellate, grayish when dry, smooth. Leaves bifoliolate, the petioles 5 mm long or less, the petiolules 5 to 8 mm long; leaflets subcoriaceous, oblong to oblong-elliptic, rather pale and shining when dry, 8 to 10 cm long, 3 to 4.5 cm wide, apex obtuse, base acute, slightly inequilateral; primary lateral nerves about 10 on each side of the midrib, slender, anastomosing, scarcely more distinct than are the secondary ones. Flowers white, fragrant, the short racemes crowded in axillary, rather dense, subcapitate inflorescences, the axis of the racemes 4 mm long or less; bracts striate, reniform, about 2 mm long and 4 mm wide, margins pubescent; pedicels about 4 mm long, glabrous. Sepals oblong, obtuse, about 2.3 mm long. Stamens 10; filaments about 4 mm long. Ovary inequilateral, oblong,

narrowed upward, glabrous or with very few scattered hairs; style curved, sparingly pubescent, about 3 mm long.

LUZON, Cagayan Province, Gattaran, *For. Bur. 24211 Barros*, August 12, 1915, on river banks, altitude about 30 meters.

A species manifestly allied to *Cynometra ramiflora* Linn., from which it is at once distinguishable by its distinctly elongated petiolules.

RUTACEAE

GLYCOSMIS Correa

GLYCOSMIS PLATYPHYLLA sp. nov.

Frutex circiter 2 m altus, inflorescentiis leviter ferrugineo-pubescentibus exceptis glaber; foliis 2- vel 3-foliolatis, foliolis coriaceis vel subcoriaceis, usque ad 18 cm longis et 9.5 cm latis, breviter late obtuseque acuminatis, basi acutis, nervis primariis utrinque 5 ad 7, subtus perspicuis, laxis, cum costa in siccitate brunneo-rubris; inflorescentiis laxis, pedunculatis, subcorymbosis, usque ad 10 cm longis, floribus 4- vel 5-meris.

A shrub about 2 m high, glabrous except the somewhat ferruginous-pubescent inflorescence. Branches and branchlets terete, brownish or reddish-brown when dry, slender. Leaves 2- or 3-foliolate, the petiole and rachis 2.5 to 5 cm long. Leaflets coriaceous or subcoriaceous, greenish-olivaceous and shining when dry, elliptic to oblong-elliptic, the larger ones up to 18 cm long and 9.5 cm wide, smaller ones on the same branches 7 to 13 cm long, 3.5 to 5 cm wide, broadly and obtusely short-acuminate, base acute, sometimes a little inequilateral; primary lateral nerves 5 to 7 on each side of the midrib, beneath reddish-brown when dry, prominent, curved, arched-anastomosing, the reticulations lax, slender, prominent; petiolules 5 to 8 mm long. Inflorescences in the uppermost axils, subcorymbose, peduncled, appressed-pubescent with short ferruginous hairs, up to 10 cm in length, lax, the flowers greenish-white, crowded on the ultimate branchlets, 4- or 5-merous. Calyx-teeth 4 or 5, rounded, less than 0.5 mm long. Young petals elliptic, rounded, concave, at least 2 mm long, externally very slightly pubescent.

LEYTE, Tigbao, near Tacloban, *Wenzel 1611*, August 23, 1915.

A species manifestly allied to *Glycosmis cochinchinensis* (Lour.) Pierre, and perhaps even referable to it under a very broad interpretation of specific limits. In its very large leaflets; lax prominent nerves which are reddish-brown when dry; and lax, peduncled, elongated inflorescences it appear to be sufficiently distinct to warrant separation from the above polymorphous species.

ARONYCHIA Forster

ACRONYCHIA OBOVATA sp. nov.

Arbor circiter 13 m alta ramulis junioribus et inflorescentiis exceptis glabra; foliis firmiter charactaceis, obovatis ad oblongo-obovatis, usque ad 14 cm longis, apice truncatis, latissime rotundatis vel obscurissime late acuminatis, deorsum angustatis, basi cuneatis, nervis primariis utrinque circiter 12; fructibus globosis, circiter 1 cm diametro, obscure apiculatis, 4-locellatis.

A tree about 13 m high, the very young branchlets and the inflorescences more or less pubescent with pale fulvous hairs, the infructescences ultimately nearly glabrous. Leaves obovate to oblong-obovate, 9 to 14 cm long, 4 to 6 cm wide, the apex truncate, broadly rounded or broadly and obscurely blunt-acuminate, narrowed below the middle to the cuneate base, rather pale when dry, shining; primary lateral nerves about 12 on each side of the midrib, distinct, anastomosing, the secondary nerves and reticulations rather prominent; petioles 2 to 2.5 cm long. Infructescences in the upper axils, peduncled, up to 8 cm in length, sparingly pubescent, ultimately glabrous or nearly so. Fruits globose, somewhat fleshy, broadly and obscurely apiculate, about 1 cm in diameter, brownish when dry, 4-celled, 4-seeded, the seeds about 5 mm long, nearly black, shining.

MINDANAO, Surigao Province, Manangas, Carrascal, *For. Bur. 26473 Mallonga*, December 13, 1916, on slopes in rich soil, altitude about 50 meters.

A species readily recognized by its obovate to obovate-oblong leaves.

SIMARUBACEAE

BRUCEA J. S. Miller

BRUCEA STENOPHYLLA sp. nov.

Frutex 2 ad 3 m altus, partibus junioribus leviter ferrugineo-pubescentibus exceptis glaber; ramis ramulisque teretibus, tenuibus, pallidis; foliis 12 ad 20 cm longis, foliolis 3 ad 5, rariter 7, membranaceis, lanceolatis, usque ad 9 cm longis, 1 ad 2 cm latis, integris vel subintegris, tenuiter acuminatis, basi acutis; infructescentiis foliis subaequantibus, tenuibus; fructibus paucis, oblongo-ovoideis, leviter acuminatis, reticulatis, leviter bicarinatis, circiter 12 mm longis.

A shrub 2 to 3 m high, glabrous except the slightly ferruginous-pubescent younger parts. Branches and branchlets slender, terete, pale. Leaves 12 to 20 cm long, distant; leaflets 3 to 5, rarely 7, opposite, the pairs distant, lanceolate, membranaceous, subolivaceous and shining when dry, entire or very rarely

with a few irregular teeth, 6 to 12 cm long, 1 to 2 cm wide, narrowed upward to the slenderly acuminate apex, the base acute; petiolules 5 mm long or less; lateral nerves 7 to 10 on each side of the midrib, slender, anastomosing, not prominent. Infructescences about as long as the leaves, slender, axillary, solitary, the peduncular portion 10 to 15 cm long. Fruits racemosely disposed, few, their pedicels 1 to 1.5 cm long, the fruits oblong-ovoid, about 12 cm long, pale, somewhat bicarinate, about 12 mm long, laxly but prominently reticulate, base rounded, apex somewhat acuminate.

LUZON, Benguet Subprovince, Baguio, *For. Bur. 26396 Oteyza & Garcia* (type), November 11, 1916, *For. Bur. 22903 Leaño,* July 9, 1914, both from thickets along small streams, altitude about 1,500 meters, the type from Forbes Park, Leaño's specimen from the barrio of Lucban.

A species well characterized by its few, very narrow, entire, distant leaflets, and its slender, greatly elongated infructescences. Its alliance is with *Brucea mollis* Wall., and with the Philippine forms described as *B. luzoniensis* Vid. and *B. membranacea* Merr.

SABIACEAE

MELIOSMA Blume

MELIOSMA BRACHYBOTRYS sp. nov.

Species *M. sylvaticae* affinis, differt foliolis majoribus, usque ad 15 cm longis, petiolo rhachibusque glabro, paniculis multo brevioribus, circiter 15 cm longis, glabris vel basi plus minusve ferrugineo-ciliato-pilosis.

A shrub, quite glabrous except the basal parts of the infructescences which are more or less ciliate-pilose with ferruginous, deciduous hairs. Branches brown, terete, the ultimate ones about 7 mm in diameter. Leaves pinnate, about 40 cm long, the petiole and rachis glabrous, pale-brown. Leaflets usually 13, brownish when dry, coriaceous, lanceolate to oblong-lanceolate, 10 to 18 cm long, 3.5 to 5 cm wide, the lower ones often falcate and more or less inequilateral at the base, apex slenderly and sharply subcaudate-acuminate, base acute, margins distantly and minutely apiculate-toothed, especially in the upper part, brownish when dry; lateral nerves 7 or 8 on each side of the midrib, prominent, curved-ascending, anastomosing, the reticulations distinct, lax; petiolules of the lateral leaflets 5 to 14 mm long, of the terminal one up to 2 cm. Panicles terminal, stout, 15 cm long or less, the rachis and short branches thick, brown, glabrous, or the base of the rachis more or less ciliate-pilose, the hairs deciduous, the branches few, 5 cm long or less. Fruits

brown or black when dry, obovoid, sessile, 5 to 6 mm long, somewhat rugose, with two distinct longitudinal ridges.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26567 Ramos & Edaño*, August 26, 1916, on forested slopes, altitude about 190 meters.

A species manifestly allied to *Meliosma sylvatica* Elm., from which it is readily distinguished by its larger leaflets; very much shorter panicles; and in being nearly glabrous throughout.

SAPINDACEAE

GUIOA Cavanilles

GUIOA OBTUSA sp. nov.

Frutex, partibus junioribus subtus foliolis et inflorescentiis uniformiter adpresse ferrugineo-pubescentibus; foliis 10 ad 13 cm longis, foliolis plerumque 4, coriaceis, oblongo-ellipticis ad oblongo-obovatis, usque ad 7 cm longis, apice obtusis, basi acuminatis, inaequilateralibus, supra glabris, nitidis, olivaceis vel nigro-brunneis, subtus pallidis, nervis utrinque 8 ad 10, perspicuis; paniculis terminalibus axillaribusque, usque ad 10 cm longis, ferrugineo-pubescentibus; floribus circiter 5 mm diametro.

A shrub about 5 m high, the younger parts, lower surface of the leaflets, and inflorescences uniformly appressed-pubescent with short ferruginous hairs. Branches terete, dark-colored, ultimately glabrous, the branchlets ferruginous-pubescent. Leaves alternate, 10 to 13 cm long, petiole and rachis pubescent; leaflets usually 4, rather thickly coriaceous, oblong-elliptic to oblong-obovate, 5 to 7 cm long, 1.5 to 3 cm wide, the upper pair distinctly larger than the lower one, obtuse, base narrowed, acuminate, inequilateral, the upper surface olivaceous to dark-brown, shining, glabrous, the lower pale, uniformly appressed-pubescent, the midrib, nerves, and reticulations brown in contrast to the pale epidermis; petiolules 3 to 5 mm long, pubescent; lateral nerves 8 to 10 on each side of the midrib, prominent on the lower surface, curved, anastomosing. Panicles axillary and terminal, up to 10 cm long, ferruginous-pubescent. Flowers pinkish-white, about 5 mm in diameter. Outer sepals ovate, obtuse, 2 mm long, the inner ones reniform-orbicular, as long as the outer ones, 3 mm wide. Petals villous, obovate, 3 mm long, base narrowed. Filaments pubescent.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26636 Ramos & Edaño*, September 19, 1916, on forested slopes, altitude about 270 meters.

A species entirely distinct from all previously described Philippine forms, apparently allied to *Guioa villosa* Radlk. of New Caledonia. It is readily distinguished by its ferruginous indumentum and its blunt leaflets.

CELASTRACEAE

ELAEODENDRON Jacquin

ELAEODENDRON MINDANAENSE sp. nov.

Arbor parva, glabra; foliis chartaceis, elliptico-ovatis, integris, usque ad 6 cm longis, basi acutis vel acuminatis, apice latissime breviter obtuse acuminatis, nervis tenuibus, primariis utrinque circiter 8, quam secondariis reticulisque vix magis prominentioribus; cymis axillaribus, brevibus; fructibus junioribus circiter 6 mm longis, obovoideis, petalis 5, orbicularis vel orbiculari-ovatis, rotundatis, circiter 1 mm longis.

A small glabrous tree attaining a height of about 10 m, the branches and branchlets slender, terete, grayish, or the latter somewhat reddish-brown. Leaves opposite, entire, chartaceous, pale-olivaceous, somewhat shining when dry, of the same color on both surfaces, elliptic-ovate or sometimes rhomboid-ovate, 3.5 to 6 cm long, 2.5 to 5.5 cm wide, narrowed to the acute or slightly acuminate base, the apex with a short, broad, blunt acumen; primary lateral nerves about 8 on each side of the midrib, slender, anastomosing, scarcely more prominent than are the secondary ones and the reticulations; petioles slender, 3 to 4 mm long. Cymes axillary, solitary, slender, the pedunclés 0.5 to 1 cm long, each usually bearing three fruits, the pedicels 2 to 2.5 mm long, somewhat thickened upward. Corolla-tube funnel-shaped, about 1 mm long, the sepals very broad, short, rounded, somewhat reniform. Petals orbicular to orbicular-ovate, about 1 mm long. Young fruits obovoid, pale when dry, the pericarp rather thin, about 6 mm long.

MINDANAO, Davao District, Mount Badas, *For. Bur. 26243 Ceballos*, September 30, 1916, near the summit of the mountain, altitude about 650 meters.

The first representative of the genus to be found in the Philippines, perhaps most closely allied to *Elaeodendron glaucum* Pers., but with much shorter, greatly reduced cymes and smaller, less prominently nerved, entire leaves.

GLYPTOPETALUM Thwaites

GLYPTOPETALUM RETICULATUM sp. nov.

Frutex 4 ad 5 m altus, glaber, ramis teretibus, ramulis compressis vel indistincte angulatis; foliis coriaceis, in siccitate pallidis, oblongis ad oblongo-ovatis, usque ad 15 cm longis, acuminatis, basi subacutis ad obtusis, brevissime petiolatis, utrinque dense reticulatis, nervis primariis circiter 8, margine minute glanduloso-denticulatis; infructescentiis axillaribus, peduncula-

tis, usque ad 7 cm longis, depauperato-cymosis; fructibus globosis, circiter 1 cm diametro.

A glabrous shrub 4 to 5 m high. Branches terete, greenish-olivaceous or brown, the branchlets pale-greenish, somewhat compressed or obscurely angled. Leaves rather thickly coriaceous, oblong-ovate to oblong, 9 to 15 cm long, 3 to 4.5 cm wide, rather pale when dry, slightly shining, both surfaces distinctly and rather densely reticulate, narrowed above to the somewhat acuminate apex, the base subacute to obtuse, margins, somewhat thickened, slightly recurved glandular-denticulate with minute teeth 2 to 5 mm apart; lateral nerves about 8 on each side of the midrib, slender, rather distinct, anastomosing; petioles 2 mm long. Infructescences axillary, peduncled, about 7 cm long, the fruits 1 to 3 on each peduncle in a depauperate cyme. Fruits reddish when fresh, globose, about 10 mm in diameter, smooth, 4-valved, but by abortion with but one or two seeds, the seeds brown when dry, about 8 mm in diameter, the aril large, somewhat fleshy, orange-red.

LUZON, Abra Province, Mount Posuey, *Bur. Sci. 27043 Ramos*, February 4, 1917, on damp forested slopes, altitude about 300 meters.

This species is well characterized by the short-petioled, rather thickly coriaceous leaves, the reticulations dense and evident on both surfaces. It is most closely allied to *Glyptopetalum marivelense* Merr.

GLYPTOPETALUM EUONYMOIDES sp. nov.

Frutex circiter 2 m altus, glaber, ramis ramulisque teretibus; foliis subcoriaceis, late ellipticis ad obovatis, usque ad 5 cm longis, apice late rotundatis, basi acutis, margine integris vel sursum obscure crenatis, in siccitate pallidis vel subolivaceis, interdum glaucescentibus, nervis primariis utrinque 4 vel 5, tenuibus, obscuris; cymis axillaribus, dichotomis, paucifloris, 4 ad 6 cm longis; floribus 4-meris, circiter 7.5 mm diametro; petalis orbiculari-reniformibus, circiter 3 mm longis; fructibus junioribus ovoideis, circiter 8 mm longis, loculicide 4-valvis, seminibus solitariis.

A glabrous shrub about 2 m high, the branches and branchlets terete, the former brown, the latter pale-greenish and 1 to 1.5 mm in diameter. Leaves subcoriaceous, broadly elliptic to obovate, 4 to 5 cm long, 2.5 to 4 cm wide, apex broadly rounded, base acute, smooth, slightly shining, entire or the margins above obscurely and distantly crenate, when dry pale to subolivaceous, sometimes more or less glaucous; lateral nerves 4 or 5 on each side of the midrib, obscure, slender, obscurely anastomosing,

the reticulations very lax; petioles 4 to 5 mm long. Cymes axillary, peduncled, dichotomous, few-flowered, 4 to 6 cm long. Flowers 4-merous, 7 to 8 mm in diameter, their pedicels 1 to 2 mm long, the bracteoles 1 mm long or less. Sepals orbicular, rounded, about 1 mm long. Petals orbicular-reniform, entire, more or less recurved, about 3 mm long and 4 mm wide. Ovules 1 in each cell. Fruit, slightly immature, ovoid, about 8 mm long, 4-valved, by abortion 1-celled, 1-seeded, the seed broadly ellipsoid, 6 to 7 mm long, the aril less than one-half as long as the seed.

LUZON, Ilocos Norte Province, Bangui, *Bur. Sci. 27546 Ramos*, February 20, 1917, on slopes in thickets at low altitudes.

In vegetative characters this species somewhat resembles a small-leaved form of *Euonymus viburnifolius* Merr. It is well characterized by its broadly elliptic to obovate leaves which are often glaucous when dry. It is not closely allied to any other known form of the genus.

GLYPTOPETALUM GLANDULOSUM sp. nov.

Frutex glaber 3 ad 4 m altus, ramis teretibus, purpureo-brunneis, ramulis concoloribus, tenuibus, sulcatis vel 4-angulatis; foliis subtus prominente brunneo-glandulosis, chartaceis vel subcoriaceis, oblongis, usque ad 7 cm longis, obtuse acuminatis, basi acutis, margine distanter crenulato-denticulatis, nervis utrinque 4 vel 5, tenuibus, perspicuis, anastomosantibus; inflorescentiis axillaribus, cymosis vel subumbellatis, paucifloris, usque ad 1.5 cm longis vel interdum floribus solitariis; floribus tenuiter pedicellatis, 4-meris, 4 ad 5 mm diametro, petalis obovatis.

A glabrous erect shrub 3 to 4 m high. Branches brownish-purple, terete, smooth, the branchlets of the same color, slender, sulcate or 4-angled, the ultimate ones about 1 mm in diameter. Leaves oblong, chartaceous to subcoriaceous, 5 to 7 cm long, 1.6 to 3 cm wide, subolivaceous, slightly shining and of about the same color on both surfaces when dry, narrowed above to the blunt-acuminate apex, the base acute, margins distantly crenate-denticulate, the lower surface with numerous, rather prominent, dark-brown glands; lateral nerves 4 or 5 on each side of the midrib, slender, distinct, arched-anastomosing, the reticulations very lax; petioles 5 to 7 mm long. Inflorescences cymose or subumbellate, few-flowered, axillary, 1.5 cm long or less, sometimes the flowers solitary. Flowers pale straw-color, 4-merous, 4 to 5 mm in diameter, their pedicels slender, 5 to 6 mm long. Outer two sepals reniform, rounded, about 1 mm long and 1.5 mm wide, the inner two distinctly larger. Petals obovate,

rounded, 2 mm long, entire. Anthers subsessile on the disk. Ovary 4-celled; cells 1-ovuled.

PALAWAN, Mount Capoas, *Merrill 9547*, April 21, 1913, on steep talus slopes, lower limits of the mossy forests, altitude about 900 meters.

A very characteristic species readily recognizable by its prominently glandular leaves.

GLYPTOPETALUM REMOTINERVIUM sp. nov.

Frutex glaber 3 ad 5 m altus, ramis ramulisque teretibus; foliis olivaceis, oblongo-ovatis ad oblongis, chartaceis, usque ad 17 cm longis, acutis vel brevissime acuminatis, basi acutis, margine obscure crenulatis, nervis utrinque circiter 6, distantibus, supra impressis, subtus perspicuis, arcuato-anastomosantibus; cymis axillaribus, depauperatis, pedunculatis, 3 ad 4 cm longis; fructibus circiter 8 mm diametro.

A glabrous shrub 3 to 5 m high, the branches and branchlets smooth, olivaceous, terete, the latter 1.5 to 2 mm in diameter. Leaves oblong-ovate to oblong, firmly chartaceous, olivaceous, of the same color and slightly shining on both surfaces when dry, 15 to 17 cm long, 5.5 to 6.5 cm wide, narrowed above to the acute or slightly acuminate apex, base acute, margins usually somewhat recurved and obscurely and distantly crenulate; lateral nerves about 6 on each side of the midrib, distant, impressed on the upper surface, very prominent on the lower surface, arched-anastomosing about 1 cm from the edge of the leaf, the reticulations very lax, obscure; petioles 6 to 8 mm long. Cymes in the upper axils, depauperate, peduncled, 3 to 4 cm long. Fruits subglobose, about 8 mm in diameter, the pericarp white or pink, the seeds red, brown when dry, ovoid, about 6 mm long.

PALAWAN, Ewiig River, *Merrill 741*, February 15, 1903 (type), in forests, altitude about 300 meters. I am convinced that *Elmer 13095*, distributed as *Euonymus alatus* Elm. belongs here, although of it I have seen only leaf specimens. It is from the same general locality as *Merrill 741*, and has nothing to do with *Euonymus alatus* Elm. which is a true *Euonymus* that I have below renamed *Euonymus elmeri* Merr.

The species is well characterized by its relatively large, remotely and prominently nerved leaves, in its distinct nerves somewhat resembling *Glyptopetalum euphlebium* Merr., differing from that species in its much fewer nerves, larger leaves, and smaller fruits.

GLYPTOPETALUM EUPHLEBIUM (Merr.) comb. nov.

Glyptopetalum marivelense Merr. var. *euphlebium* Merr. in Philip. Journ. Sci. 10 (1915) Bot. 322.

The form that I characterized as a variety of *Glyptopetalum marivelense* Merr. I now consider to be specifically distinct. It differs from *Glyptopetalum marivelense* Merr. in its somewhat longer, relatively narrower leaves,

which are up to 15 cm in length and 2.5 to 4 cm wide, and especially in its more numerous lateral nerves which are impressed on the upper surface, very prominent beneath and arched-anastomosing; there are 10 to 12 pairs of lateral nerves, while in *G. marivelense* Merr. there are but 6 or 7 pairs which are not impressed on the upper surface and not very prominent on the lower surface.

LUZON, Zambales Province, Mount Tapulao, *For. Bur. 8108 Curran & Merritt*, December 15, 1907, in forests, altitude 100 to 1400 meters.

EUONYMUS Linnaeus

EUONYMUS ELMERI nom. nov.

Euonymus alatus Elm. Leafl. Philip. Bot. 4 (1912) 1484, non Regel.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25436 Yates*, December, 1916.

This species was originally described from specimens collected on Sibuyan Island, and is known only from the original collections, *Elmer 12256, 12485*, and the specimen cited above. *Elmer 13095* from Palawan, distributed as *E. alatus* Elm., of which I have seen only leaf specimens, is *Glyptopetalum remotinovium* Merr.

PLEUROSTYLIA Wight

PLEUROSTYLIA WIGHTII W. & A. Prodr. (1834) 157, var. NEOCALEDONICA Loesen.

LUZON, Batangas Province, Mount Batulao, *Bur. Sci. 22350 Ramos*, July 27, 1914, on dry hills.

The specimen is an exact match for New Caledonian material, *Balansa 570, Hennecart s. n.*, representing the variety named by Loesener; I have not seen the description of this variety. Both the New Caledonian material and the Luzon specimen are distinctly different from typical Ceylon material of *Pleurostylia wightii* W. & A. The genus is new to the Philippines.

VITACEAE

LEEA Linnaeus

LEEA ACUMINATISSIMA sp. nov.

Species *L. unifoliolatae* Merr. affinis, differt foliis minoribus, coriaceis, grosse crenato-serratis, basi rotundatis cordatisque.

A shrub about 1 m high, entirely glabrous, the branches terete, brown, about 5 mm in diameter. Leaves simple, lanceolate to oblong-lanceolate, coriaceous, mostly 10 to 17 cm long, 3 to 5 cm wide, sometimes up to 22 cm long and 7 cm wide, brownish-olivaceous, apex caudate-acuminate, acumen slender, up to 2 cm long, base rounded, distinctly cordate, margins coarsely crenate-serrate, the upper surface brownish-olivaceous when dry, the lower surface paler; lateral nerves about 12 on each side of the midrib, prominent, anastomosing, the reticulations subparallel, distinct; petioles about 2 cm long, channeled, with narrow deciduous marginal wings. Infructescences ter-

minal, very short, 2 cm long or less, the immature fruits green, black when dry, globose, 5 to 7 mm in diameter.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26260 Ramos & Edaño*, August 14, 1916, on forested slopes, altitude about 350 meters, locally known as *paratalak*.

A very characteristic species closely allied to *Leea unifoliolata* Merr., from which it is readily distinguishable by its smaller, coriaceous, caudate-acuminate, coarsely toothed, fewer-nerved leaves, which are rounded and distinctly cordate at the base.

ELAEOCARPACEAE

ELAEOCARPUS Linnaeus

ELAEOCARPUS FORBESII sp. nov. § *Dicera*.

Arbor circiter 10 m alta partibus junioribus et inflorescentiis exceptis glabra; foliis coriaceis, ellipticis, usque ad 13 cm longis, basi rotundatis vel obtusis, apice obtuse acuminatis, margine distanter crenatis, nervis utrinque 7 ad 9, subtus cum reticulis primariis perspicuis; petiolo 1.2 ad 3 cm longo; racemis axillaribus, solitariis, 2 ad 4 cm longis, adpresse pubescentibus; floribus 5-meris, confertis, circiter 9 mm longis, sepalis petalisque extus uniformiter adpresse pubescentibus, petalis oblongo-obovatis, 8 mm longis, laciniatis, laciniae circiter 15, usque ad 3 mm longae; staminibus circiter 14, antheris anguste oblongis, obtusis, circiter 2.7 mm longis, appendiculatis; ovario 3-loculare.

A tree about 10 m high, quite glabrous except the younger parts and the inflorescence. Branches terete, rugose when dry, dark-brown, the branchlets obscurely pubescent, the indumentum dark-brown, appressed. Leaves coriaceous, elliptic, rather pale when dry, 9 to 13 cm long, 3.5 to 6.5 cm wide, base rounded or obtuse, apex shortly and obtusely acuminate, sometimes apiculate, margins distantly crenate; lateral nerves 7 to 9 on each side of the midrib, very prominent on the lower surface, curved, anastomosing, the primary reticulations very prominent, lax, the ultimate ones very distinct; petioles 1.2 to 3 cm long. Racemes in the upper axils, solitary, 2 to 4 cm long, rather densely flowered, all parts rather densely pubescent with pale brownish or grayish, appressed, shining hairs. Flowers whitish, 5-merous, about 9 mm long, their pedicels pubescent, about 4 mm long. Sepals lanceolate, externally densely appressed-pubescent, about 7 mm long, 2.2 mm wide below, gradually narrowed upward, somewhat acuminate. Petals narrowly oblong-obovate, about 8 mm long, externally densely appressed-pubescent with

pale, shining hairs, internally appressed-villous especially in the median part and along the margins, the base obtuse, the apex divided in the upper 3 mm into about 14, irregular, slender, laciniae. Stamens about 14; filaments 2 to 2.5 mm long; anthers slightly longer then the filaments, narrowly oblong, up to 2.8 mm in length, one cell obtuse, the other slightly longer, acute, not at all bearded or awned. Ovary ovoid, pubescent, 3-celled; style glabrous, 6 mm long.

LUZON, Benguet Subprovince, Baguio, Forbes Park, *For. Bur. 24726 Leaño* (type), September 27, 1915, *Sandkuhl 342*, July 28, 1915, from the same tree.

This tree grows along streams in the pine region at an approximate altitude of 1,300 meters. It seems to be most closely allied to *Elaeocarpus burebidensis* Elm., of Mindanao, from which it is easily distinguished by its differently shaped, much longer-petioled leaves. This characteristic species is dedicated to the Honorable W. Cameron Forbes, ex-Governor of the Philippines, in whose honor Forbes Park at Baguio was named.

GONYSTYLACEAE

GONYSTYLUS Teysmann and Binndendyck

GONYSTYLUS OBOVATUS sp. nov.

Arbor circiter 20 m alta, inflorescentiis exceptis glabra; foliis subcoriaceis, obovatis, usque ad 9 cm longis, apice rotundatis, leviter obtuse acuminatis vel retusis, basi late acutis, supra minutissime puncticulatis, subtus eglandulosis, nervis primariis utrinque circiter 20, quam secondariis haud magis distinctioribus; inflorescentiis terminalibus, solitariis, 4 ad 9 cm longis; fructibus junioribus longe pedunculatis, ellipsoideis, circiter 2.5 cm longis.

A tree about 20 m high, glabrous except the inflorescence. Branches reddish-brown, terete, rugose when dry. Leaves subcoriaceous, obovate, 6 to 9 cm long, 4 to 7 cm wide, rather pale when dry, shining, the apex broadly rounded, sometimes retuse, or even slightly acuminate, the base broadly acute; lateral primary nerves about 20 on each side of the midrib, evident on both surfaces but scarcely more distinct than are the secondary ones and the reticulations; petioles reddish-brown, 1.5 to 2 cm long. The upper surface minutely puncticulate, the lower eglandular. Inflorescences terminal and in the upper axils, solitary, apparently racemose, nearly glabrous at maturity. Flowers unknown. Fruits brown when dry, rugose, ellipsoid, about 2.5 cm long, the stout peduncles 2 to 2.5 cm long. Per-

sistent calyx-lobes ovate, coriaceous, glabrous externally, inside densely hirsute.

BABUYAN ISLANDS, Calayan, *For. Bur. 26713 Peñas*, May 19, 1917, in forests, altitude about 30 meters.

The alliance of this species is with *Gonystylus philippinensis* Elm., of Sibuyan Island, from which it differs in its differently shaped leaves which are eglandular beneath. Its extra-Philippine alliance is with *Gonystylus bancanus* Baill., which is represented by numerous Philippine collections. To this genus pertains the species described by Elmer as *Thea reticulata* Elm. Leafl. Philip. Bot. 8 (1915) 2838 (*Elmer 13478*, Agusan Subprovince, Mindanao), which should be called **GONYSTYLUS RETICULATUS** (Elm.); it is apparently closely allied to the Bornean *Gonystylus affinis* Radlk.

GUTTIFERAE

GARCINIA Linnaeus

GARCINIA MULTIBRACTEOLATA sp. nov. § *Xanthochymus*.

Arbor glabra, circiter 15 m alta, ramis teretibus, ramulis teretibus vel obscure angulatis; foliis coriaceis, olivaceis, nitidis, oblongo-ellipticis, usque ad 15 cm longis, apice obtusis, acutis, vel obscurissime acuminatis, basi decurrento-acuminatis, nervis primariis utrinque circiter 16, tenuibus; inflorescentiis ♂ terminalibus, fasiculatis, ramulis elongatis, 1 ad 2 cm longis, bracteolis numerosis imbricatis quadrifariis instructis; floribus solitariis, terminalibus, 5-meris, sepalis petalisque similibus, sepalis circiter 5 mm longis; phalangibus 5, utrinque polyandris; corpus centrale fungiforme, pedicellatum.

A glabrous tree, about 5 mm high, the branches terete, olivaceous, somewhat wrinkled when dry, the branchlets more or less angular. Leaves coriaceous, olivaceous, shining, of the same color on both surfaces, oblong-elliptic, base somewhat decurrent-acuminate, apex obtuse, acute, or slightly acuminate, margins somewhat cartilaginous-thickened, usually more or less revolute; primary lateral nerves about 16 on each side of the midrib, somewhat spreading, rather slender, anastomosing, the secondary ones and primary reticulations nearly as prominent; petioles stout, 6 to 10 mm long. Inflorescence terminal, each consisting of from 5 to 8, stout, 1 to 2 cm long, 1-flowered, fascicled rachises, the rachises supplied with very numerous, crowded, imbricate, triangular-acute bracteoles about 2 mm long and 3 mm wide, arranged in four series, making the rachis more or less 4-angled. Male flowers 5-merous, solitary, sessile, terminal, pinkish-white. Sepals 5, coriaceous, elliptic, concave, about 5 mm long. Petals similar to the sepals but, in bud, somewhat smaller. Phalanges 5, free nearly to the base, densely covered on all surfaces with

very numerous, minute anthers. Rudimentary ovary fungiform, the disk-like stigma about 1.4 mm in diameter, peduncled.

MINDANAO, Surigao Province, Placer, *Wenzel 1806*, June 20, 1916, in forests, altitude about 150 meters.

The alliance of this species is manifestly with *Garcinia moselleyana* Pierre, from which it is readily distinguished by its remarkable, elongated, fascicled, stout, quadrifarously multibreaceolate rachises or partial inflorescences.

GARCINIA HETEROPHYLLA sp. nov.

Arbor parva, glabra, ramulis teretibus; foliis sessilibus vel brevissime petiolatis, lanceolatis ad ovatis, acuminatis, basi rotundatis ad perspicue cordatis, usque ad 10 cm longis, coriaceis, nervis utrinque 7 ad 9, tenuibus, anastomosantibus, reticulis laxis; fructibus axillaribus, solitariis, subsessilibus, globosis, carnosis, circiter 3 cm diametro.

A small glabrous tree, the branches and branchlets brown, terete. Leaves coriaceous, brown when dry, slightly shining, lanceolate to ovate, 6 to 10 cm long, 2 to 5 cm wide, the lanceolate ones usually rounded at the base, the ovate ones prominently cordate, sessile or very shortly petioled, apex prominently blunt-acuminate; lateral nerves 7 to 9, slender, anastomosing, the reticulations lax. Fruits axillary, solitary, globose, fleshy, sessile or subsessile, about 3 cm in diameter, dark-brown when dry, the pericarp thin, each with about three seeds.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26457 Ramos & Edaño*, August 13, 1916, in forests, altitude about 300 meters.

A very characteristic species, allied to *Garcinia cordata* Merr., from which it is at once distinguished by its few-nerved leaves. The sessile or subsessile, lanceolate to ovate leaves are very characteristic, the former usually rounded at the base, the latter deeply cordate, the lobes partly surrounding the branchlets.

KAYEA Wallich

KAYEA MEGALOCARPA sp. nov.

Frutex vel arbor parva, glabra, ramis et ramulis teretibus; foliis coriaceis, laevis, nitidis, oblongis ad oblongo-lanceolatis, usque ad 25 cm longis, obtuse acuminatis, basi rotundatis, nervis primariis utrinque circiter 20, tenuibus; petiolo crasso, 6 ad 8 mm longo; fructibus terminalibus, solitariis, pedunculatis, in siccitate brunneis, furfuraceis, globosis vel ovoideis, circiter 4 cm diametro.

A shrub or small tree, entirely glabrous, the branches and branchlets terete, the former brown or greenish-olivaceous, the latter reddish-brown. Leaves oblong to oblong-lanceolate, co-

riaceous, smooth, shining, of about the same color on both surfaces, rather pale when dry, 20 to 25 cm long, 4 to 7 cm wide, base rounded, apex obtusely acuminate; lateral nerves about 20 on each side of the midrib, slender, anastomosing; petioles reddish-brown, 6 to 8 m long. Fruit globose or ovoid, about 4 cm in diameter, brown when dry, externally furfuraceous, terminal, solitary, the peduncle about 2 cm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26360 Ramos & Edaño*, August 17, 1916, in forests at low altitudes.

A characteristic species allied to *Kayea navesii* Vesque, from which it differs by its leaves rounded at the base, its much longer petioles, and its much larger fruits.

VIOLACEAE

RINOREA Aublet

RINOREA GLANDULOSA (Elm.) comb. nov.

Gelonium glandulosum Elm. Leafl. Philip. Bot. 3 (1910) 917.
Rinorea fasciculata var. *minor* Elm. Leafl. Philip. Bot. 8 (1915) 2877.

The type of *Gelonium glandulosum* Elm. is *Elmer 12315* from Sibuyan; the type of *Rinorea fasciculata* var. *minor* is *Elmer 12724* from Palawan. Regarding the former Pax & Hoffmann[2] state: "certissime non ad genus pertinet", and an examination of the specimen shows it to be a *Rinorea*, from which I do not believe that *Rinorea fasciculata* var. *minor* Elm. can be distinguished. The species is distinguished from *Rinorea fasciculata* (Turcz.) Merr. by a number of characters, notably its smaller, fewer-nerved leaves. The same species is represented by *For. Bur. 24769 Vergara* from Panay, with the Visayan name *calumpingan*.

RINOREA FASCICULATA (Turcz.) comb. nov.

Pentaloba fasciculata Turcz. in Bull. Soc. Nat. Mosc. 27 (1854) 341.
Alsodeia fasciculata F.-Vill. Novis. App. (1880) 12.

This species is now represented by a number of collections from various parts of the Philippines. The type is *Cuming 1074*, not localized, but probably from Zambales Province, Luzon.

RINOREA FORMICARIA (Elm.) comb. nov.

Alsodeia formicaria Elm. Leafl. Philip. Bot. 5 (1913) 1850.

The type of this species is *Elmer 12886* from Palawan. I have already noted elsewhere[3] that *Alsodeia dubia* Elm. is no violaceous plant but pertains to the *Euphorbiaceae* and is *Trigonopleura dubia* (Elm.) Merr. (*T. philippinensis* Merr.). *Rinorea pulgarensis* Elm. Leafl. Philip. Bot. 5 (1913) 1849 is likewise no violaceous plant but pertains to the *Ebenaceae* and is **DIOSPYROS PULGARENSIS** (Elm.) Merr., a species apparently allied to *Diospyros fasciculiflora* Merr.

[2] Engl. Pflanzenreich 63 (1914) 414.
[3] Philip. Journ. Sci. 11 (1916) Bot. 77.

COMBRETACEAE

TERMINALIA Linnaeus

TERMINALIA CRASSIRAMEA sp. nov.

Arbor 5 ad 15 m alta, ramulis junioribus incrassatis, 1 ad 2 cm diametro, cicatricibus multis prominentibus ornatis, plus minusve rufo-villosis; foliis confertis, brevissime petiolatis, oblongo-obovatis, firmiter chartaceis, usque ad 35 cm longis, apice rotundatis plerumque abrupte breviterque apiculato-acuminatis, deorsum angustatis, basi circiter 2 cm latis, leviter cordatis, nervis utrinque 25 ad 35, subtus perspicuis, anastomosantibus cum costa reticulisque prominentibus plus minusve rufo- vel ferrugineo-pubescentibus; fructibus junioribus ellipsoideis, cylindraceis, circiter 3.5 cm longis, breviter apiculatis, laevis, glabris.

A tree 5 to 15 m high, more or less ferruginous- or rufous-pubescent, the branches smooth, glabrous, stout, the upper 3 to 10 cm of the ultimate branchlets much thickened, cylindric, 1 to 2 cm in diameter, strongly marked with the numerous large scars of fallen petioles, the leaves crowded at the apices of the branchlets. Leaves oblong-obovate, firmly chartaceous to subcoriaceous, 23 to 35 cm long, 7 to 16 cm wide, olivaceous or greenish-olivaceous when dry, the upper surface glabrous, shining, the lower somewhat paler, more or less ferruginous- or rufous-pubescent on the midrib, nerves, and reticulations, the apex rounded, usually shortly and abruptly apiculate, gradually narrowed in the lower one-half to two-thirds, the base about 3 cm wide, somewhat cordate; lateral nerves very prominent, 25 to 35 on each side of the midrib, anastomosing, the reticulations subparallel, prominent; petioles stout, 5 mm long or less, pubescent to glabrous. Infructescences axillary, up to 14 cm in length, the immature fruits ellipsoid, olivaceous, cylindric, not at all compressed, about 3.5 cm long, 2.5 cm in diameter, glabrous, shining, slightly apiculate.

LEYTE, near Ormoc, *For. Bur. 12764 Rosenbluth* (type), March 13, 1909, in valleys, second-growth forests, and open country, altitude about 40 meters, locally known as *lanipao; For. Bur. 11583 Whitford,* March 16, 1909, sterile. The same species occurs in Agusan Subprovince, Mindanao, represented in the herbarium by three sterile specimens, *For. Bur. 7568 Hutchinson, For. Bur. 24400 Cortez & Fernandez, For. Bur. 24460 Miras, Mariano, & Valderrama,* all bearing the Visayan name *lanipao,* and one the Manobo name *yanipao.*

This most characteristic species is readily distinguishable by its much thickened, prominently scarred branchlets, its crowded, large, short-petioled, many-nerved leaves, which are gradually narrowed below to the slightly cordate base, and its ellipsoid smooth fruits that are not at all compressed. It is not closely allied to any previously described Philippine form.

MYRTACEAE

TRISTANIA R. Brown

TRISTANIA MICRANTHA sp. nov.

Arbor 20 m alta (fide Oro), inflorescentiis distincte cinereo-pubescentibus exceptis glabra; foliis oblongo-ellipticis, usque ad 13 cm longis, obtusis vel latissime obtuse acuminatis, nitidis, basi acuminatis, nervis utrinque 20 ad 30, tenuibus, subtus distinctis, anastomosantibus, in pagina inferiore minutissime puncticulatis; inflorescentiis axillaribus terminalibusque, pedunculatis, laxis, usque ad 10 cm longis, partibus junioribus distincte cinereo-pubescentibus; floribus circiter 2 mm longis, 5-meris, calycibus extus cinereo-puberulis, petalis suborbicularibus, 1.2 mm diametro, integris, glabris; staminibus 15, filamentis brevissimis; ovario pubescente, 3-loculare.

A tree about 20 m high (fide Oro), glabrous except the distinctly cinereous-pubescent inflorescences. Branches terete, pale brownish, the branchlets terete, smooth, reddish-brown. Leaves alternate, in general oblong-elliptic, 7.5 to 13 cm long, 3 to 4.5 cm wide, shining when dry, the upper surface brownish-olivaceous, the lower paler and very minutely glandular-puncticulate, apex obtuse to very broadly blunt-acuminate, base acuminate, margins slightly recurved; lateral nerves slender but distinct, 20 to 30 on each side of the midrib, anastomosing with the distinct marginal nerves about 2 mm from the edge of the leaf; petioles about 1 cm long. Cymes axillary and terminal, lax, 5 to 10 cm long, peduncled, dichotomously branched, the peduncles reddish-brown, nearly glabrous, the younger parts rather densely cinereous-pubescent. Flowers about 2 mm long, 5-merous, their pedicels pubescent, 1.5 to 2.5 mm long. Calyx turbinate, cinerous-pubescent, about 2 mm long, the teeth 5, short, rounded. Petals glabrous, suborbicular, rounded, entire, 1.2 mm in diameter. Stamens 15, in five groups of three each, the filaments glabrous, less than 0.5 mm long. Ovary pubescent, 3-celled.

SAMAR, near Catbalogan, *For. Bur. 22877 Oro*, August 18, 1914, on steep slopes, altitude about 400 meters, locally known as *tiga busag*.

The alliance of this species is manifestly with *Tristania decorticata* Merr. which it closely resembles in many characters. It differs in its larger leaves; much longer inflorescences which in their younger parts are rather densely cinereous-pubescent; smaller flowers; and much shorter stamens.

XANTHOSTEMON F. Mueller

XANTHOSTEMON PHILIPPINENSIS sp. nov.

Arbor circiter 20 m alta, partibus junioribus leviter ferrugineo-pubescentibus exceptis glabra; foliis ellipticis ad obovato-ellipticis, coriaceis, usque ad 7 cm longis, in siccitate pallidis, subtus puncticulatis, apice rotundatis, basi decurrento-acuminatis; floribus flavis, cum staminibus circiter 2.5 cm longis, in axillis superioribus vel inflorescentiis racemosis efformantibus.

A tree about 20 m high, glabrous except the more or less ferruginous-pubescent young branchlets. Branches terete, reddish-brown. Leaves alternate, crowded toward the ends of the branchlets, elliptic to obovate-elliptic, coriaceous, pale and somewhat shining when dry, 4 to 7 cm long, 2.5 to 3.5 cm wide, apex rounded, base decurrent-acuminate, the lower surface glandular-punctate; lateral nerves about 10 on each side of the midrib, slender; petioles up to 1 cm in length. Flowers in the uppermost axils and forming terminal racemes, yellow, their pedicels about 1 cm long. Calyx-tube cup-shaped, about 5 mm long and 8 mm in diameter, the lobes 5, reniform, about 2 mm long and 4 to 5 mm wide, their margins minutely ciliate. Petals 5, suborbicular, rounded, 7 to 8 mm in diameter. Disk very prominent, lining the perianth-tube, about 8 mm in diameter, distinctly projecting beyond the insertion of the filaments. Stamens about 24, their filaments about 15 mm long. Ovary superior, ovoid, 3-celled; style 2 cm long.

LUZON, Camarines Province, Paracale, *For. Bur. 24812 de Mesa*, November 30, 1915, altitude about 40 meters, locally known as *canacanala*.

A very characteristic species, at once distinguished from *Xanthostemon verdugonianus* Naves by its larger yellow flowers and its prominent disk. In vegetative characters the two species are very similar.

XANTHOSTEMON BRACTEATUS sp. nov.

Arbor glabra; foliis coriaceis, oblongo-obovatis, usque ad 18 cm longis, apice obtusis ad obtuse acuminatis, deorsum angustatis, basi cuneatis, in siccitate supra pallidis vel flavicantibus, subtus saepe cupreis, puncticulatis, nervis utrinque circiter 12; inflorescentiis axillaribus, circiter 12 cm longis, paucifloris, bracteis multis lanceolatis foliaceis instructis; floribus albidis, circiter 3.5 cm diametro, 5-meris, petalis orbiculari-obovatis, sepalis ovato-lanceolatis, acuminatis, staminibus circiter 25; capsulis 1 cm diametro, 3-locellatis, 3-valvatis.

A glabrous tree attaining a height of at least 14 m, the young buds somewhat pubescent. Branches terete, brownish. Leaves

alternate, coriaceous, generally oblong-obovate, 11 to 18 cm long, 4 to 8 cm wide, apex obtuse to obtusely acuminate, narrowed below to the cuneate base, when dry pale or yellowish on the upper surface, the lower surface more or less cupreous, glandular-punctate; lateral nerves about 12 on each side of the midrib, rather prominent, irregular, anastomosing with the marginal nerves, the reticulations lax; petioles about 5 mm long. Inflorescences axillary, about 12 cm long, simple or forked, racemose, few-flowered, supplied with numerous, lanceolate, coriaceous, leaf-like bracts 1.5 to 2 cm in length. Flowers white, about 3.5 cm in diameter, the pedicels 5 mm long or less. Calyx-tube shallow, 1 to 1.2 cm in diameter, the lobes spreading, persistent, ovate-lanceolate, acuminate, about 9 mm long. Petals orbicular-obovate, rounded, 1.3 to 1.5 cm long. Stamens about 25, 1-seriate on the prominent disk which is about 1 cm in diameter. Ovary 3-celled; style 13 mm long. Capsule about 1 cm in diameter, sugblobose, sometimes slightly 3-lobed, 3-celled, 3-valved, brown when dry; seeds very numerous, flat, thin.

LUZON, Camarines Province, Paracale, *For. Bur. 26500 de Mesa & Magistrado*, on low hills, altitude about 30 meters.

The same species is represented by a sterile specimen from Mambulao, *For. Bur. 13350 Aguilar*, and from Samar, *For. Bur. 25961 Cortes*. It is known in Camarines Province as *diricalin*, and in Samar as *bagoadlao*. The wood is hard and in Camarines Province it is considered to be one of the most durable building timbers. The species is very distinct from the two other Philippine forms, and does not appear to be closely allied to any of the described extra-Philippine ones.

SYMPLOCACEAE

SYMPLOCOS Jacquin

SYMPLOCOS OBOVATIFOLIA sp. nov.

Arbor glaberrima, 5 ad 10 m alta; foliis coriaceis vel subcoriaceis, obovatis ad anguste obovatis, usque ad 12 cm longis, nitidis, subintegris vel obscure crenulato-denticulatis, apice rotundatis ad breviter obtuse acuminatis, basi cuneatis vel acutis, nervis utrinque 6 vel 7, plus minusve adscendentibus, subtus perspicuis; fructibus numerosis, axillaribus, solitariis vel fasciculatis, oblongis, cylindraceis, 1 cm longis, calycibus lobis 3, ovatis, obtusis.

An entirely glabrous tree (flowers not seen), 5 to 10 m high. Branches brownish, terete, smooth, the branchlets greenish-olivaceous, somewhat angled when dry. Leaves alternate, coriaceous or subcoriaceous, greenish-yellow, of the same color on both surfaces and shining when dry, obovate to narrowly ob-

ovate, 8 to 12 cm long, 3.5 to 6 cm wide, apex rounded to shortly and obtusely acuminate, below generally narrowed to the acute or cuneate base, the margins entire or very obscurely and distantly crenulate-dentate; lateral nerves 6 or 7 on each side of the midrib, prominent, more or less ascending, anastomosing, the reticulations lax; petioles stout, about 1 cm long. Fruits axillary and in the axils of fallen leaves, solitary or fascicled, or subspicately arranged on the very short axis, sessile, oblong, cylindric, 3-celled, 1 cm long, smooth, the basal bracteoles broadly ovate, obtuse, 2.5 mm long, glabrous; calyx-lobes crowning the fruit three, ovate, obtuse, 1.5 to 2 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26447* (type), *26466 Ramos & Edaño*, August 11 and 15, 1916, on forested slopes, altitude between 250 and 400 meters.

A most characteristic species, readily distinguished by being entirely glabrous, and by its obovate or narrowly obovate leaves; its numerous, sessile, oblong, cylindric fruits; and its 3-merous calyx, the latter a character apparently new, or at least very rare, in the genus.

SYMPLOCOS TRISEPALA sp. nov. § *Babua, Lodhra.*

Arbor parva, partibus junioribus et foliis subtus ad costa parcissime longe ciliatis exceptis glabra; foliis oblongo-ellipticis ad oblongo-ovatis, coriaceis, usque ad 10 cm longis, acuminatis, basi obtusis, margine distanter glanduloso-denticulatis, nervis utrinque circiter 7, subtus perspicuis; spicis axillaribus, glabris, dense paucifloris, 1 ad 1.5 cm longis; calycibus tubo brevissimo, lobis 3, ovatis, obtusis, circiter 3 mm longis.

A small tree, entirely glabrous except for the widely scattered, long, ciliate hairs on the very youngest parts, petioles, and midribs on the lower surface of the leaves, perhaps ultimately entirely glabrous. Branches terete, reddish-brown, the branchlets greenish-olivaceous, somewhat compressed. Leaves oblong-ovate to oblong-elliptic, coriaceous, 7 to 10 cm long, 3 to 4.5 cm wide, yellowish-green when dry, shining, the apex distinctly and rather sharply acuminate, base obtuse, margins distantly glandular-denticulate, the gland-like teeth small, black when dry; lateral nerves 7 on each side of the midrib, very prominent on the lower surface, anastomosing, the reticulations lax, prominent, the midrib impressed on the upper surface; petioles 2 to 2.5 cm long. Spikes axillary, solitary, glabrous, 1 to 1.5 cm long, the flowers rather few, densely arranged, the subtending bracteoles ovate to elliptic-ovate, obtuse, coriaceous, 3 to 4 mm long, their margins glandular-denticulate. Flowers white or somewhat yellowish. Calyx-tube 1.5 mm long, the lobes 3, broadly ovate, obtuse, about 3 mm long. Petals 5, broadly ovate to elliptic-ovate, 3.5 to 4

mm long. Stamens about 50, obscurely pentadelphous, the filaments glabrous, 3 to 7 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26515 Ramos & Edaño*, September 6, 1916, in forests, altitude at least 400 meters.

It is very curious that two very distinct species of *Symplocos* should be collected on the same mountain both aberrent within the genus in their 3-lobed calyces. The present species is immediately distinguishable from *Symplocos obovatifolia* Merr. in numerous characters, notably in its entirely differently shaped leaves; its sparse ciliate indumentum; and its spicately arranged flowers.

SYMPLOCOS ELLIPTIFOLIA sp. nov. § *Bobua, Lodhra.*

Frutex circiter 3 mm altus, ramulis junioribus foliis subtus ad costa et inflorescentiis exceptis glaber; foliis subcoriaceis, ellipticis, usque ad 4 cm longis, utrinque acutis vel apice subobtusis minutissime apiculatisque, margine crenato-serrulatis, nervis utrinque 5 vel 6, distinctis, anastomosantibus; spicis axillaribus, pubescentibus, solitariis, 1 ad 1.5 cm longis, circiter 10 floris; calycibus tubo glabro, lobis ovatis, obtusis, margine ciliatis; petalis elliptico-ovatis, circiter 3 mm longis; staminibus circiter 60, obscure pentadelphis.

A shrub about 3 m high, glabrous except the ferrugineous-pubescent young branchlets, inflorescences, and the sparsely pubescent midrib on the lower surface of the leaves. Branches terete, smooth, dark reddish-brown. Leaves elliptic, subcoriaceous, 3 to 4 cm long, 1.4 to 2.4 cm wide, subequally narrowed to the acute base and the acute or subobtuse and minutely apiculate apex, margins crenate-serrulate, the upper surface brownish-olivaceous when dry, shining, the lower surface paler, yellowish-green, the midrib slightly impressed on the upper surface; lateral nerves 5 or 6 on each side of the midrib, slender, distinct, anastomosing, these and the rather lax reticulations subequally prominent on both surfaces, the midrib slightly pubescent on the lower surface. Spikes axillary, solitary, up to 1.5 cm long, about 10-flowered, appressed ferrugineous-pubescent; bracteoles ovate, pubescent, obtuse, about 1 mm long. Calyx-tube glabrous, cylindric, slightly enlarged upward, about 2 mm long, the lobes 5, ovate, 2 mm long, their margins ciliate, otherwise glabrous. Petals elliptic-ovate, rounded, 3 to 3.5 mm long. Stamens about 60, obscurely pentadelphous.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26512 Ramos & Edaño*, September 6, 1916, in forests, altitude at least 300 meters.

This species somewhat resembles *Symplocos inconspicua* Brand, but has very differently shaped, fewer-nerved leaves, and differs also in its ciliate calyx-segments. From *Symplocos vidalii* Rolfe (*S. luzoniensis* Brand, non

Rolfe) it differs in its shorter, more numerously flowered spikes and ovate, not lanceolate, bracteoles and calyx-segments.

SYMPLOCOS RAMOSII sp. nov. § *Bobua*.

Arbor, ramulis junioribus et inflorescentiis ferrugineo-pubescentibus exceptis glabra; foliis oblongo-ellipticis ad elliptico-ovatis, usque ad 12 cm longis, chartaceis, apice perspicue acuminatis ad subcaudato-acuminatis, basi acutis, margine obscure crenulato-dentatis, nervis utrinque 10 ad 12; inflorescentiis axillaribus pseudo-terminalibusque, elongatis, parce ramosis, ramulis plerumque 1 ad 3, usque ad 10 cm longis; floribus 5-meris, sessilibus, numerosis, circiter 8 mm diametro.

A tree, glabrous except the ferruginous-pubescent younger branchlets and the inflorescences. Branches and older parts of the branchlets brown, smooth, terete. Leaves scattered, chartaceous, oblong-elliptic to elliptic-ovate, subequally narrowed at both base and apex, the base acute, the apex rather prominently acuminate, sometimes subcaudate-acuminate, margins crenate-dentate, the teeth not prominent, when dry yellowish-green or greenish-olivaceous, of the same color on both surfaces, shining; lateral nerves 10 to 12 on each side of the midrib, rather slender but prominent on the lower surface, anastomosing; petioles 1.3 to 2 cm long, blackish when dry. Inflorescences elongated, axillary and pseudo-terminal, up to 12 cm in length, rather densely appressed-ferruginous-pubescent with short hairs, the branches few, usually 1 to 3, up to 10 cm in length. Flowers 5-merous, numerous, spicately arranged, white, about 8 mm in diameter, the subtending bracteoles three, broadly ovate, pubescent, obtuse to subacute, about 1.5 mm long. Sepals 5, broadly orbicular-ovate, obtuse, pubescent, 1.5 mm long. Petals elliptic to elliptic-ovate, rounded, about 3 mm long. Stamens about 40, obscurely pentadelphous, their filaments 3 to 5 mm long.

LUZON, Laguna Province, San Antonio, *Bur. Sci. 23801 Ramos*, October 18, 1915, on open hillsides at medium altitudes.

The alliance of this species is apparently with *Symplocos ahernii* Brand, from which it differs in numerous characters, notably in its greatly elongated spikes.

ERICACEAE

VACCINIUM Linnaeus

VACCINIUM MYRTOIDES (Blume) Miq. Fl. Ind. Bat. 2 (1859) 1062.

Thibaudia mytoides Blume Bijdr. (1826) 861.

Vaccinium villarii Vid. Rev. Pl. Vasc. Filip. (1886) 166; Merr. in Philip. Journ. Sci. 3 (1908) Bot. 374.

The type of Blume's species was from the Moluccas: "in cacumine montium ignivomorum insularum Moluccarum", and all published descrip-

tions of it are very short and imperfect. *Koorders 19438, 19429* from Klabat and Sepoetan, Celebes, exactly match our very full series of Philippine *Vaccinium villarii* Vid., and as the specimens conform with Blume's diagnosis, I have no hesitation in reducing Vidal's species to the much older *Vaccinium myrtoides* Miq. This adds another characteristic species to the already long list of those that are known only from the Philippines and Celebes, or from the Philippines and the Moluccas.

VACCINIUM PLATYPHYLLUM sp. nov.

Frutex vel arbor parva inflorescentiis exceptis glabra; foliis ellipticis ad oblongo-ellipticis, usque ad 14 cm longis et 7 cm latis, crasse coriaceis, integris, in siccitate pallidis, nitidis, basi acutis, apice prominente acuminatis, nervis utrinque 4 vel 5, tenuibus, adscendentibus; racemis axillaribus, solitariis, parce pubescentibus, 4 ad 6 cm longis, bracteis oblongo-lanceolatis, acuminatis, circiter 8 mm longis, supersistentibus; corolla circiter 5 mm longa, extus leviter pubescentibus; ovario pubescente; calycibus lobis acutis, 1.2 mm longis, extus pubescentibus.

A shrub or small tree, glabrous except the inflorescence. Branches pale-brownish, terete, smooth, the younger branchlets reddish-brown, somewhat angular, rather stout. Leaves alternate, rather distant, thickly coriaceous, stiff, elliptic to ovate- or oblong-elliptic, 11 to 14 cm long, 5 to 7 cm wide, entire, rather pale when dry, base acute, apex prominently acuminate, the acumen rather broad, 1 to 1.5 cm long; lateral nerves 4 or 5 on each side of the prominent midrib, slender, ascending, mostly leaving the midrib in the lower one-third, obscurely anastomosing, the reticulations not prominent; petioles stout, about 1 cm long. Racemes axillary, solitary, 4 to 6 cm long, sparingly pubescent, the bracts subpersistent, oblong-lanceolate, acuminate, about 8 mm long, black when dry. Pedicels about 7 mm long, slightly pubescent. Corolla 5 mm long, externally sparingly pubescent, narrowed upward, the mouth about 1.5 mm in diameter, the short, broadly ovate, obtuse lobes recurved. Anthers 1.5 mm long. Ovary pubescent. Young fruit cup-shaped, 3 mm long, pubescent, the persistent calyx-teeth triangular-acute, 1.2 mm long.

LUZON, Tayabas Province, vicinity of Dingalan on the Pacific coast, *Bur. Sci. 26583 Ramos & Edaño*, August 25, 1916, on slopes at an altitude of about 200 meters.

This is perhaps as closely allied to *Vaccinium perrigidum* Elm., as to any other described species. It is characterized by its large, faintly and obliquely nerved leaves, and its slightly pubescent racemes.

VACCINIUM ANGUSTILIMBUM sp. nov.

Frutex glaber, circiter 3 m altus; foliis coriaceis, lanceolatis ad oblanceolatis, integris, usque ad 6 cm longis et 1 cm latis,

nitidis, utrinque subaequaliter angustatis, apice obtusis ad leviter acuminatis, basi cuneatis, tenuiter 3-nerviis, nervis lateralibus adscendentibus, margine revolutis; petiolo crasso, brevissimo; racemis terminalibus, solitariis, sub fructu circiter 3 cm longis; fructibus globosis, 5 ad 6 mm diametro, dentibus ovatis, obtusis, 1 mm longis.

A glabrous shrub, about 3 m high, the branches terete, the branchlets brownish, obscurely angled or subterete. Leaves numerous, rather crowded, thickly coriaceous, stiff, lanceolate to oblanceolate, 4 to 6 cm long, 7 to 10 mm wide, subequally narrowed to the cuneate base and to the blunt to obscurely acuminate apex, margins entire, recurved, olivaceous when dry, the lower surface often brownish, glandular, the base slenderly 3-nerved, the lateral basal nerves extending one-half to two-thirds to the apex; lateral nerves, including the basal pair, 3 or 4 on each side of the midrib, slender, sharply ascending, the primary reticulations rather distinct; petioles stout, about 1 mm long. Racemes terminal, solitary, in fruit about 3 cm long, the pedicels up to 5 mm in length. Fruits globose, black when dry, 5 to 6 mm in diameter, the persistent calyx-teeth ovate, blunt, about 1 mm long.

LUZON, Tayabas Province, vicinity of Dingalan, *Bur. Sci. 26603 Ramos & Edaño*, September 10, 1916, in forests, altitude about 300 meters.

A characteristic species distinguishable by its narrow, thickly coriaceous, slenderly nerved leaves. It is perhaps as closely allied to *Vaccinium jagori* Warb. as any other described form, but is very different from Warburg's species.

EBENACEAE

MABA Forster

MABA MULTIBRACTEATA sp. nov. § *Rhipidostigma?*

Arbor parva, 4 ad 6 m alta, dioica, ramulis valde elongatis, usque ad 1 m longis, subpendulis, plus minusve adpresse hirsutis; foliis chartaceis vel subcoriaceis, oblongis, usque ad 20 cm longis, brevissime petiolatis, basi cordatis, apice acuminatis, subtus obscure puncticulatis, nervis utrinque circiter 10, perspicuis; floribus ♂ 3-meris, axillaribus, cylindraceis, 10 mm longis, fasciculatis; staminibus 8 vel 9, antheris glabris; fructibus sessilibus, ovoideo-ellipsoideis, 2.5 cm longis, obtusis, in siccitate brunneis, 4-locellatis; seminibus 4, albumine aequabile; bracteis numerosis, lanceolatis, hirsutis, 6 ad 12 mm longis.

A dioecious tree, 4 to 6 m high, the branches very long, subpendulous, the ultimate one up to 1 m in length, the younger branches, petioles, inflorescences, and to a much less degree the

leaves ferruginous-pubescent with short, stiff, appressed hairs. Leaves oblong, chartaceous to subcoriaceous, brown or suboliva-ceous when dry, 11 to 20 cm long, 3.5 to 8 cm wide, base rounded, cordate, apex somewhat acuminate, both surfaces with widely scattered hairs on the midrib and nerves, the lower sur-face obscurely puncticulate; petioles 2 to 3 mm long; lateral nerves about 10 on on each side of the midrib, prominent, anas-tomosing, the reticulations lax. Flowers crowded in axillary, dense, multibracteate fascicles, the bracts lanceolate, acuminate, prominently pubescent, persistent, 6 to 10 mm long. Staminate flowers cylindric, 10 to 11 mm long, externally densely appressed-pubescent. Calyx 4.5 mm long, pubescent, 3-lobed, the lobes ovate, acuminate, about 2 mm long. Corolla lobes 3, elliptic-ovate, apiculate-acuminate, about 3 mm long, the median portion of the back pubescent, the broad margins glabrous. Stamens 8 or 9, inserted at the base, the longer filaments 2 mm long; anthers linear, glabrous, 2 mm long. Pistillate flowers not seen. Fruits ovoid-ellipsoid, obtuse, about 2.5 cm long, glabrous, sessile, brown and shining when dry, 4-celled, each cell with a single seed. Seeds oblong, pointed at both ends, about 1.8 cm long, triangular in cross-section, the two inner faces plane, the outer convex, the chartaceous testa dark-brown, free, somewhat puncticulate, the albumen very hard, pale-brownish, uniform, not at all ruminate.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 25641, 26361* (type) *Ramos & Edaño*, August, 1916; Sangirin, Alabat Island, *Merrill 10441*, December, 1916; Basiad, *Bur. Sci. 25592 Yates*, December, 1916, along small streams in forests at low altitudes.

A characteristic species that by definition might almost as well be placed in *Diospyros* as in *Maba*. On account of its trimerous flowers and its apparently alliance with *Maba punctata* Hiern, I have placed it in the latter genus. It is readily recognized by its nearly sessile cordate leaves and dense, multibracteate fascicles.

LOGANIACEAE

GENIOSTOMA Forster

GENIOSTOMA LONGIPES sp. nov.

Frutex glaber, circiter 2 m altus, ramis teretibus, ramulis distincte 4-angulatis; foliis in siccitate nigris, ellipticis ad ob-longo-ellipticis, chartaceis vel subcoriaceis, nitidis, utrinque sub-aequaliter angustatis, basi acutis, apice acutis vel leviter acu-minatis, usque ad 7 cm longis, nervis utrinque 4 vel 5, distinctis; fructibus axillaribus, solitariis vel binis, longe pedunculatis,

ovoideis vel subglobosis, in siccitate nigris, circiter 6 mm diametro.

A glabrous shrub, about 2 m high, the branches terete, grayish or brownish, the branchlets distinctly 4-angled. Leaves black when dry, shining, chartaceous to subcoriaceous, 5 to 7 cm long, 2 to 3 cm wide, elliptic to oblong-elliptic, subequally narrowed to the acute base and the acute or somewhat acuminate apex; lateral nerves 4 or 5 on each side of the midrib, slender, curved, obscurely anastomosing; petioles about 2 mm long; stipules broader then long, subacute. Fruits axillary, solitary or in pairs, globose or ovoid, black when dry, about 6 mm in diameter, their peduncles 2 to 2.5 cm long, with few scattered, minute bracts.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26536 Ramos & Edaño*, September 8, 1916, in forests, altitude about 300 meters, locally known as *bitig-bitig*.

A characteristic species, distinguishable by its long-peduncled solitary or paired fruits; the peduncles simple, 2 to 2.5 cm long. The other Philippine species have the flowers and fruits arranged in depauperate cymes. In vegetative characters the present species is nearest to *Geniostoma batanense* Merr., but differs totally in the characters of its infructescence.

THYMELAEACEAE

WIKSTROEMIA Endlicher

WIKSTROEMIA PACHYPHYLLA sp. nov.

Frutex glaber, circiter 3 m altus; foliis coriaceis vel subcoriaceis, olivacies, nitidis, late ellipticis, usque ad 7 cm longis et 5.5 cm latis, apice late rotundatis, basi late rotundatis interdum leviter cordatis; fructibus ellipsoideis, circiter 9 mm longis.

A glabrous shrub, about 3 m high, the branches and branchlets smooth, reddish-brown, terete, or the latter somewhat compressed. Leaves broadly elliptic, 6.5 to 7 cm long, 4.5 to 5.5 cm wide, broadly rounded at both base and apex, or the base sometimes slightly cordate, when dry olivaceous, shining, the lower surface slightly paler than the upper; lateral nerves about 8 on each side of the midrib, rather distinct on the lower surface, somewhat curved, anastomosing, the reticulations lax; petioles about 2 mm long. Fruits red, fleshy, when dry ellipsoid, about 9 mm long.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25559 Yates*, December 14, 1916, in forests, altitude about 400 meters.

A species well characterized by its broadly elliptic, rounded, comparatively large leaves. In spite of the great differences in vegetative characters, its alliance seems to be with *Wikstroemia viridiflora* Meisn.

VERBENACEAE

CALLICARPA Linnaeus

CALLICARPA WEBERI sp. nov.

Arbor circiter 8 m alta, ramulis petiolis et inflorescentiis et subtus foliis densissime uniformiter stellato-pubescentibus, indumento ferruginèo vel subferrugineo; foliis subcoriaceis, ovatis ad elliptico-ovatis, integris, usque ad 14 cm longis, basi rotundatis ad acutis, apice obtusis ad breviter acute acuminatis, supra, costa exceptis, glabris, eglandulosis, brunneis, subtus uniformiter dense subferrugineo-tomentosis, vetustioribus foveolatis; cymis e axillis superioribus, longe pedunculatis, densifloris, calycibus densissime stellato-tomentosis, corollae tubo extus puberulo 4 mm longo.

A tree about 8 m high, the younger parts densely and uniformly ferruginous-pubescent with short stellate hairs, the indumentum on the older parts and on the lower surfaces of the leaves paler but equally dense. Branches terete, the younger branchlets obscurely angled. Leaves subcoriaceous, ovate to elliptic-ovate, 8 to 14 cm long, 5 to 8 cm wide, entire, base rounded to acute, apex obtuse to shortly and acutely acuminate, the upper surface smooth, shining, dark-brown or olivaceous-brown, eglandular, glabrous except the midrib and lateral nerves, these sometimes minutely stellate-pubescent, the lower surface very densely and uniformly stellate-pubescent with short, pale to ferruginous hairs, the glands not evident, the older leaves distinctly pitted or foveolate beneath; lateral nerves 7 on each side of the midrib, prominent, curved, the reticulations distinct; petioles 1.5 to 5 cm long. Cymes in the upper axils, about 8 cm long and up to 6 cm wide, long-peduncled, all parts densely pale- or ferruginous-pubescent, dichotomously branched, the purplish flowers densely crowded; peduncles about 5 cm long; bracts linear, 5 to 6 mm long, the bracteoles similar but much smaller; pedicels about 2 mm long. Calyx cup-shaped, densely stellate-pubescent, 2 to 2.3 mm long, truncate, the teeth 4, minute, obscure. Corolla-tube puberulent externally, 4 mm long, the lobes oblong, obtuse, 1.5 mm long; stamens 4, the anthers oblong, 3 mm in length, exserted.

BANCALAN, between Palawan and Balabac, *C. M. Weber*, September 26, 1916, altitude about 6 meters.

This species is an ally of *Callicarpa arborea* Roxb. and *C. maingayi* King & Gamble, differing from both, however, in many characters; and of the Philippine *Callicarpa magna* Schauer, differing from the latter in its smaller leaves, densely stellate-pubescent calyx, and puberulent corolla.

It is apparently most closely allied to *Callicarpa arborea* Roxb., but its cymes are much smaller and usually but once or twice forked; its leaves smaller and fewer nerved; its flowers larger; and its ovaries are slightly glandular but not tomentose.

CALLICARPA SUBINTEGRA sp. nov.

Arbor parva, 3 ad 5 m alta, partibus junioribus subtus foliis et inflorescentiis densissime subalbido- vel griseo-stellato-puberulis; foliis lanceolatis, chartaceis, usque ad 11 cm longis, tenuiter caudato-acuminatis, basi acutis, integris vel parcissime distanter denticulatis, supra olivaceis, glabris, nitidis, subtus albidis, nervis utrinque circiter 8, perspicuis, curvato-adscendentibus; cymis axillaribus, solitariis, dichotomis, pedunculatis, usque ad 2.5 cm longis et 4 cm latis; floribus in ramulis ultimis confertis, sessilibus vel brevissime pedicellatis, calycibus truncatis, extus dense albido-stellato-tomentosis.

A small tree, 3 to 5 m high, the younger parts, lower surface of the leaves and the inflorescences very densely and uniformly stellate-puberulent, the indumentum white or brownish-white. Branches terete, pale-brown, ultimately glabrous. Leaves lanceolate, chartaceous, 8 to 11 cm long, 1.5 to 2 cm wide, entire or the margins distantly and obscurely denticulate, base acute, apex slenderly caudate-acuminate, the upper surface olivaceous, smooth, shining, glabrous, or the midrib sometimes stellate-pubescent, the lower surface entirely covered with the very dense, pale indumentum, no glands evident; lateral nerves about 8 on each side of the midrib, curved-ascending, anastomosing, the primary reticulations distinct; petioles 1 to 1.5 cm long, densely stellate-puberulent. Cymes axillary, solitary, dichotomously branched, up to 2.5 cm long and 4 cm wide, all parts very densely stellate-puberulent, the peduncles 1 cm long or less, the bracts of the primary branches linear, up to 5 mm long, those of the secondary branches similar but shorter. Flowers densely crowded on the ultimate branchlets, sessile or subsessile. Calyx 1.5 mm in diameter, truncate or minutely and obscurely 4-toothed, externally densely pale puberulent. Corolla 2.5 mm long, glabrous, the lobes 4, broadly ovate, obtuse, 1 mm long. Anthers exserted, 1 mm long. Style glabrous, 4 mm long. Young fruit ellipsoid to obovoid, glabrous, 2.5 to 3 mm in diameter, black when dry.

LUZON, Tayabas Province, Mount Dingalan, *Bur. Sci. 26619 Ramos & Edaño*, August 25, 1916, on dry slopes, altitude about 200 meters, locally known as *matarangao*.

In some respects this species resembles *Callicarpa angusta* Schauer, from which it is readily distinguished by its denser indumentum, its entire or but slightly toothed leaves, fewer nerves, and longer petioles. Its true

alliance is with *Callicarpa longipetiolata* Merr., from which it is at once distinguished by its differently shaped, narrow, caudate-acuminate leaves.

Var. **PARVA** var. nov.

A typo differt foliis minoribus, leviter acuminatis, haud caudato-acuminatis. Foliis 5 ad 7 cm longis, 1 ad 1.5 cm latis.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26465 Ramos & Edaño*, August 13, 1916, on forested slopes, altitude about 350 meters.

CALLICARPA ALBIDO-TOMENTELLA sp. nov.

Frutex circiter 2 m altus, ramulis et subtus foliis densissime albido-tomentellis vel puberulis; foliis lanceolatis, integris, membranaceis, usque ad 11 cm longis, supra glabris, brunneo-olivaceis, sursum angustatis, tenuiter acute acuminatis, basi angustatis, obtusis, interdum leviter inaequilateralibus, nervis utrinque 5 vel 6, tenuibus; cymis axillaribus, paucifloris, dichotomis, pedunculatis, 1.5 ad 2 cm longis; calycibus truncatis vel obscurissime 4-denticulatis, circiter 2 mm diametro, extus minute stellato-puberulo.

A shrub about 2 m high. Branches slender, terete, glabrous, grayish, the branchlets very densely and minutely grayish- or whitish-puberulent as is the lower surface of the leaves, the indumentum stellate. Leaves membranaceous, entire, lanceolate, 7 to 11 cm long, 1.5 to 2.5 cm wide, gradually narrowed upward to the slenderly and sharply acuminate apex, narrowed below to the obtuse base, the base on some leaves slightly inequilateral, the upper surface glabrous, brownish-olivaceous, slightly shining, the lower entirely covered with the minute indumentum; lateral nerves 5 or 6 on each side of the midrib, slender, ascending, impressed on the upper surface, the reticulations here lax, very obscure, entirely obscured by the indumentum on the lower surface; petioles densely stellate-puberulent, 4 to 5 mm long. Cymes axillary, 1.5 to 2 cm long, densely stellate-puberulent, slender, peduncled, dichotomous, few-flowered, the peduncle exceeding the primary branches; pedicels slender, 1 to 1.2 mm long, the bracteoles acicular, nearly as long as the pedicels. Fruits subglobose, purplish when fresh, about 2.5 mm in diameter, glabrous, the calyx shallow, 2 mm in diameter, truncate or very obscurely 4-denticulate, outside at the base densely stellate-puberulent with very short white hairs.

LUZON, Abra Province, Mount Posuey, *Bur. Sci. 26976 Ramos*, February 5, 1917, along small streams in forests, altitude about 120 meters.

A most characteristic species, distinguished by its white or grayish-white, very short, dense indumentum, and its entire, lanceolate, mem-

branaceous leaves which are entirely glabrous on the upper surface. It somewhat resembles *Callicarpa angusta* Schauer, but is not closely allied to that species.

CALLICARPA PHANEROPHLEBIA sp. nov.

Frutex 1 ad 2 m altus, ramis ramulisque teretibus, partibus junioribus stellato-tomentosis; foliis chartaceis, lanceolatis vel oblongo-lanceolatis, usque ad 15 cm longis, supra glabris, nitidis, olivaceis, subtus brunneo-olivaceis, glandulosis, glabris vel ad costa stellato-tomentosis, apice tenuissime caudato-acuminatis, basi obtusis, margine perspicue serrato-dentatis, nervis primariis utrinque circiter 7, curvato-anastomosantibus, valde prominentibus; cymis axillaribus, laxis, pedunculatis, usque ad 6 cm longis latisque, paucifloris.

A shrub about 2 m high, the younger parts distinctly stellate-tomentose with pale-brownish hairs, the older parts glabrous. Branches terete, brownish, glabrous, the branchlets very slender, the younger parts densely stellate-tomentose. Leaves lanceolate to oblong-lanceolate, chartaceous, 11 to 15 cm long, 2 to 4 cm wide, narrowed upward to the very slender, caudate-acuminate apex, the acumen 1 to 2 cm long, the base obtuse, margins prominently dentate-serrate, the teeth somewhat apiculate, the upper surface olivaceous, somewhat shining, glabrous, or the midrib somewhat stellate-tomentose, the lower surface brownish-olivaceous, shining, with very numerous, shining glands in minute pits, the midrib and sometimes the lateral nerves stellate-tomentose; lateral nerves about 7 on each side of the midrib, very prominent, curved-ascending, anastomosing, the reticulations lax, prominent; petioles stellate-tomentose, about 3 mm long. Cymes axillary, solitary, few-flowered, very lax, up to 6 cm long and wide, dichotomously branched, more or less stellate-tomentose, the peduncles 2 cm long. Flowers purplish, their pedicels 0.5 mm long, jointed to the branchlets. Bracts linear, 1 to 1.5 mm long. Calyx cup-shaped, truncate or very obscurely 4-toothed, 1.4 mm long and wide. Fruits globose, glabrous, wrinkled when dry, 3 mm in diameter.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26233 Ramos & Edaño*, August 8, 1916, in open places along streams, altitude about 50 meters.

A species well characterized by its slenderly caudate-acuminate, prominently toothed, nearly glabrous, very prominently nerved leaves, and its lax, few-flowered inflorescences. It is perhaps as closely allied to *Callicarpa dolichophylla* Merr. as to any other described species, but is entirely different in its vegetative and inflorescence characters.

PREMNA Linnaeus

PREMNA LEYTENSIS sp. nov.

Frutex circiter 3 m altus, partibus junioribus et inflorescentiis exceptis glaber, ramis teretibus, pallidis; foliis integris, ovatis ad oblongo-ovatis, subcoriaceis, in siccitate pallide brunneis, nitidis, usque ad 10 cm longis, prominente acute acuminatis, basi rotundatis, nervis utrinque circiter 5; inflorescentiis terminalibus, corymbosis, circiter 6 cm longis, laxis, calycis obscure bilabiatis lobis altero bidentato altero integro.

A shrub about 3 m high, the younger parts and the inflorescence more or less pubescent. Branches terete, pale-gray, glabrous. Leaves entire, ovate to oblong-ovate, subcoriaceous, when dry pale-brownish, somewhat shining, 6 to 10 cm long, 3 to 4 cm wide, narrowed upward to the prominently and sharply acuminate apex, the base rounded, entirely glabrous, or the lower surface slightly bearded in the axils; lateral nerves 5 on each side of the midrib, very prominent, curved-anastomosing, the reticulations lax; petioles 1 to 2 cm long. Inflorescence terminal, corymbose, distinctly ferruginous-pubescent with short hairs, up to 6 cm long and 10 cm wide, the primary branches few, spreading, the lower ones up to 5 cm long, the bracts linear, about 3 mm long, the bracteoles similar but smaller. Calyx cup-shaped, slightly ferruginous-pubescent, about 2 mm long, distinctly 2-lipped, one lip emarginate or broadly 2-toothed, the other entire. Corolla-tube somewhat pubescent externally, the throat bearded, about 4 mm long, 2-lipped, the upper lip entire, the lower 3-lobed, the central lobe somewhat larger than the two lateral ones, all rounded.

LEYTE, Tigbao, near Tacloban, *Wenzel 1364*, June 14, 1914, the flowers green and white.

A species in the group with *Premna integrifolia* Linn. f., but its leaves quite different in shape, prominently and rather sharply acuminate, and not at all olivaceous when dry.

CLERODENDRON Linnaeus

CLERODENDRON MABESAE sp. nov.

Species *C. minahassae* Miq. affinis, differt florbus multo longioribus, corollae tubo circiter 14 cm longo. Arbor parva, circiter 7 m alta, glabra; foliis oblongis ad oblongo-obovatis, submembranaceis, usque ad 36 cm longis, acuminatis, basi acutis, nervis utrinque circiter 10, prominentibus; inflorescentiis terminalibus, brevissime pedunculatis; calycibus circiter 4 cm longis, extus glandulosis, plus minusve inflatis, lobis anguste lanceolatis, acuminatis, circiter 2 cm longis.

A glabrous tree about 7 m high, the branches brownish, the ultimate branchlets somewhat 4-angled. Leaves oblong to oblong-obovate, submembranaceous, greenish or olivaceous and of the same color on both surfaces when dry, shining, minutely puncticulate on both surfaces, 30 to 36 cm long, 8 to 12 cm wide, entire or with very few, widely scattered, minute teeth, the apex acuminate, base acute; lateral nerves about 10 on each side of the midrib, prominent, curved, anastomosing, the primary reticulations very lax and prominent; petioles 4 to 5 cm long. Panicles terminal, about 10-flowered, the peduncle very short, including the rachis about 2 cm in length. Flowers white, fragrant. Calyx somewhat inflated, about 4 cm long, chartaceous, glandular-punctate externally, brownish when dry, somewhat angled, base cuneate, divided to about the middle into five, narrowly-lanceolate, acuminate lobes. Corolla-tube slender, about 12 cm long and 2 mm in diameter, the lobes spreading, lanceolate to oblanceolate, about 4 cm long, 5 to 7 mm wide.

LUZON, Laguna Province, forests back of Paete, *For. Bur. 26796 Mabesa*, March 27, 1917, on moist shaded slopes, altitude about 370 meters.

A remarkable species, manifestly allied to *Clerodendron minahassae* Miq., from which it differs in its much longer flowers.

THE PHILIPPINE JOURNAL OF SCIENCE, C. BOTANY.
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THE RATE OF GROWTH OF SOME TREES ON THE GEDEH, JAVA

By WILLIAM H. BROWN and HARRY S. YATES

(*From the College of Liberal Arts, University of the Philippines and the Botanical Section of the Biological Laboratory, Bureau of Science, Manila*)

A very excellent and complete method of labeling trees in a mixed tropical forest has been devised in Java by Dr. S. H. Koorders. The primary purpose of this scheme was to select and label fine typical specimens, of known diameter and height, so that they could be readily found and examined by any one interested in them. The system is so complete that any one visiting the area, even though for the first time and without a guide, should have no difficulty in finding any desired tree. Among the many areas, originally so labeled, is an extensive one on the Gedeh above the mountain station at Tjibodas. Doctor Koorders [1] has written a very full description of the labeled trees on this area.

While the writers were on a recent trip (1917) to Java, Doctor Koorders, knowing that one of us had made a large number of measurements of the rates of growth of trees in the Philippines, suggested that it would be interesting for us to remeasure some of his labeled trees on the Gedeh to ascertain how much they had grown in the twenty-seven years which had elapsed since they were first measured. As the time at our disposal was very short, we could measure only a small proportion of the trees. This was particularly so, as many of the trunks were overgrown with large vines. Moreover, it was not usually possible to determine accurately the rates of growth of the largest individuals as most of them had extensive buttresses which extended above the point where the measurements should have been made.

Doctor Koorders made the original measurements at breast height, or 1.3 meters above the ground. In order to obtain exact determinations of the rate of growth it would be necessary to be sure not only that the same point on the circumference was

[1] Koorders, S. H., Floristischer Überblick über die Blütenpflanzen des Urwaldes von Tjibodas auf dem Vulkan Gede in West-Java nebst einer Numerliste und einer systematischen Übersicht der dort für botanische Untersuchungen von mir numerierten Waldbäume, *Engl. Bot. Jahrb.* 50 (1914) Suppl. 278–303.

used for measuring the 1.3 meters above ground but also to know that the contour of the ground had not changed. Of the last we cannot, of course, be absolutely sure, and so there may be slight errors in our calculations, but we do not believe that there are any serious ones.

The forest on the Gedeh back of Tjibodas has a very irregular canopy. Doctor Koorders has made an extensive search for the tallest trees and found that the species attaining the greatest height was *Altingia excelsa,* one of the tallest individuals of which was 49 meters high. Most of the trees are, however, very much smaller than this. The tallest trees are found at the lower altitudes just back of Tjibodas. As higher elevations are reached the trees become much smaller until at the top of the mountain the canopy is only a few meters high. The forest at altitudes between 1,300 and 1,500 meters, where our measurements were made, is a fairly open one. Although the forest is tall for a mountain type, it has many of the characteristics of a tropical, high-mountain forest: among these are the prominence of species of *Podocarpus* and a considerable development of a mossy covering and other epiphytes. The relative humidity is constantly high and the rainfall is heavy. Von Faber [2] gives the rainfall and relative humidity for this forest for the years 1912–13. In 1912 the monthly rainfall varied from 256 to 398 millimeters, and in 1913 from 95 to 386 millimeters. The mean monthly relative humidity in 1912 varied between 93 and 98 per cent and in 1913 between 92 and 97 per cent.

In Table I is given a list of the trees measured on the Gedeh, including the height and diameter of each as originally determined by Doctor Koorders. In this same table we have calculated the annual rate of growth of these trees by subtracting the diameters as measured in 1890 from the figures obtained by us in 1917 and dividing the remainder by 27. The rates of growth are classified according to diameter classes of 10 centimeters, the classification being based on the diameter of the trees when the original measurements were made.

The trees labeled by Doctor Koorders were selected, not with an idea of obtaining rates of growth but to authentically label the best specimens of the individual species in the forest. As trees show different rates of growth at different ages we cannot, from our calculations, determine the age of any individual of a species or of the forest in general, nor can we tell whether or not the rates of growth obtained for the individual trees are

[2] Von Faber, F. C., Physiologische Fragmente aus einem tropischen Urwald, *Jahrb. Wiss. Bot.* **56** (1915) 197–220.

TABLE I.—*Annual diameter growth of trees in the virgin forest on the Gedeh in Java at altitudes between 1,300 and 1,500 meters.*

Species.	Height.	Diameter.	Diameter class in centimeters.					
			10–20	20–30	30–40	40–50	50–60	60–70
Lauraceae.	*m.*	*cm.*						
Litsea mappacea (Bl.) Boerl	10	27.0		0.55				
Machilus rimosa Bl	15	16.0	0.35					
Phoebe excelsa Nees	20	55.0					0.90	
Do	26	63.5						0.80
Leguminoseae.								
Pithecolobium montanum Benth	15	18.0	0.35					
Meliaceae.								
Dysoxylum alliaceum Bl	9	31.5			0.30			
Toona febrifuga Bl	25	45.0				1.35		
Euphorbiaceae.								
Glochidion cyrtostylum Miq	20	26.0		0.40				
Ostodes paniculata Bl	15	35.0			0.25			
Macaranga rhizinoides (Bl.) Muell.-Arg	20	30.0		0.20				
Aceraceae.								
Acer niveum Bl	10	18.0	0.70					
Do	15	27.0		0.20				
Sapindaceae.								
Mischocarpus fuscescens Bl	20	31.0			0.05			
Do	15	20.0			0.05			
Elaeocarpaceae.								
Elaeocarpus pierrei Kds. et Val	18	23.0		0.60				
Sloanea sigun Szysz	18	32.0			0.10			
Theaceae.								
Eurya acuminata DC	18	21.0		0.30				
Schima noronhae Reinw	35	55.0					0.40	
Myrtaceae.								
Eugenia cuprea Kds. et Val	23	46.0				0.05		
Eugenia densiflora (DC.) Duthie	15	28.0		0.20				
Do	15	34.0			0.35			
Eugenia operculata Roxb	21	44.5				1.00		
Myrsinaceae.								
Rapanea hasseltii (Bl.) Mez	26	21.0		0.60				
Symplocaceae.								
Symplocos costata (Bl.) Choisy	18	37.0			0.20			
Symplocos fasciculata Zoll	8	10.0	0.20					
Do	14	18.0	0.35					
Rubiaceae.								
Nauclea lanceolata Bl	23	28.5		0.15				
Average			0.39	0.36	0.19	0.80	0.65	0.80
Years in 10-centimeter diameter class			26.0	28.0	53.0	13.0	15.0	13.0

fast or slow for the species concerned. Brown and Matthews [3] found that in the virgin forests of the Philippines some of the

[3] Brown, W. H., and Matthews, D. M., Philippine dipterocarp forests, *Philip. Journ. Sci.* A 9 (1914) 413–561.

larger individual trees showed a slow rate of growth and others of the same species a rapid rate.

Realizing the above objections, we have, in order to compare the data obtained from the trees on the Gedeh with those growing in other regions, treated them as though the age of the forest could be determined from them. To do this we have calculated the number of years required for the average of all the trees of a given diameter class to grow 10 centimeters or in other words to pass through the 10 centimeters diameter class. As the smallest diameter class was from 10 to 20 centimeters we calculated the age of the trees as beginning with a diameter of 10 centimeters, and by adding together the number of years required for trees to pass through the successive diameter classes, arrived at figures, which for purposes of comparison can be regarded as the ages of trees of given diameters of from 20 to 70 centimeters. These results are plotted in fig. 1 in which the ordinates represent diameters and the abscissae years. This treatment is justified to some extent by the fact that most of the trees are very much smaller than the maximum size given by Koorders [4] in his Exkursionsflora, while only one individual of one species, *Symplocos costata*, has obtained the maximum size. This individual, however, showed a faster rate of growth than the average of its diameter class.

In the same figure are also plotted the average rates of growth for a large number of species on Mount Mariveles, Philippine Islands, at altitudes between 400 and 500 meters and the average rates of growth of five representative species in the northern Laguna forest, Philippine Islands.[5] In the same figure we have plotted the rates of growth of yellow poplar in Virginia and Tennessee and of white oak in Tennessee and Kentucky.[6] The original figures for yellow poplar and white oak were in inches. In order to make these figures comparable with our results, we converted the inches into centimeters and plotted them on coordinate paper. From these curves we obtained the numbers used in plotting the curves in figure 1.

An examination of figure 1 shows that the rates of growth obtained on the Gedeh are not very different from those for white oak and yellow poplar and for the species in the forest of northern Laguna. The figures obtained for rates of growth on the Gedeh cannot, of course, be regarded as final, except for the

[4] Koorders, S. H., Exkursionsflora von Java (1911–1912).

[5] Brown, W. H., and Matthews, D. M., op. cit.

[6] Graves, H. S., and Ziegler, E. A. The woodman's handbook, *U. S. Forestry Service Bull.* 36 (1910) 189, 190.

particular individuals and for these only for the period covered by the measurements. However, as most of the curve for rates of growth on the Gedeh lies between those for yellow poplar and white oak, it seems not improbable that the trees on the Gedeh

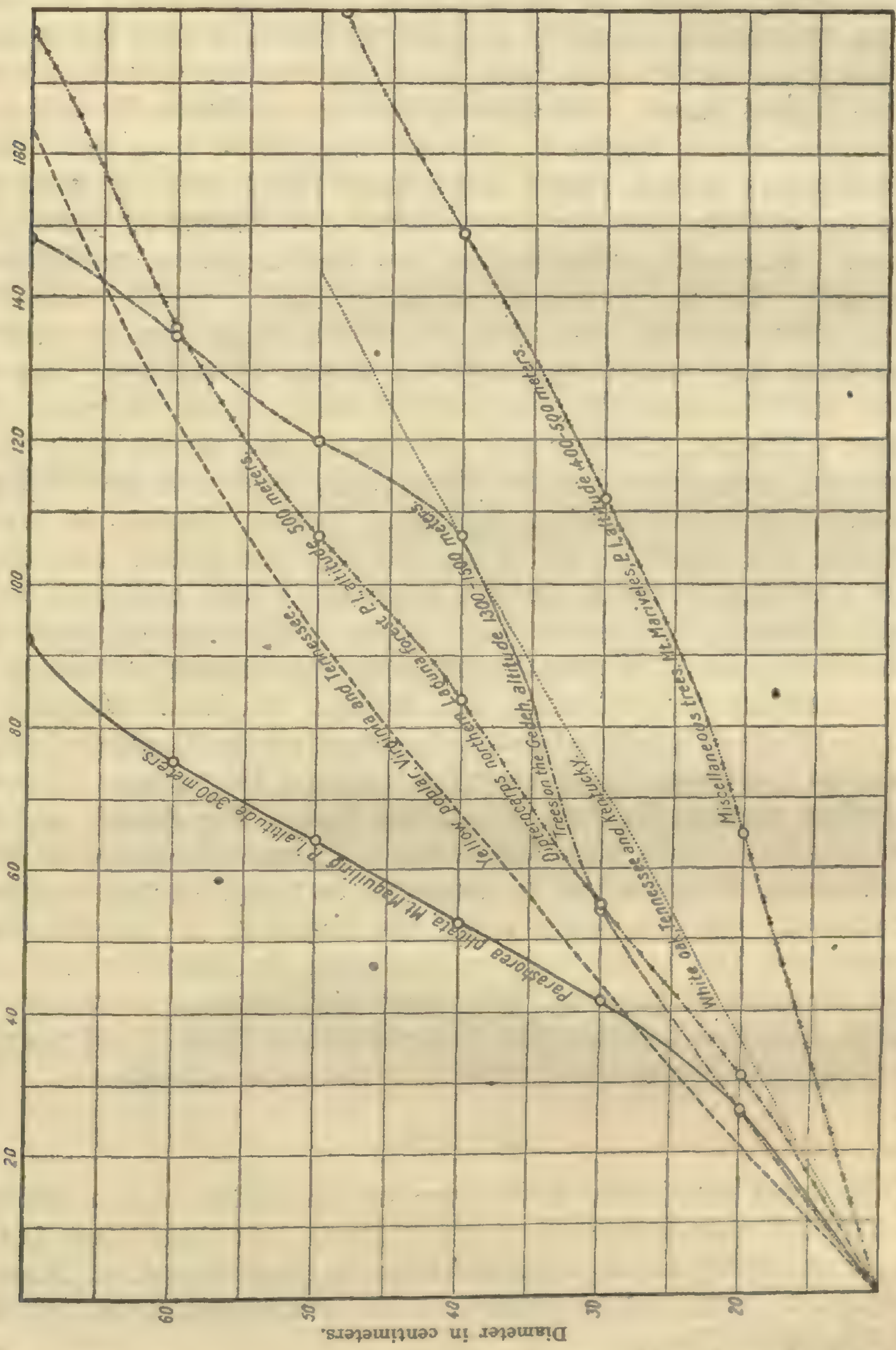

FIG. 1. Comparison of the rates of growth of trees on the Gedeh, Java, with those for trees in other regions.

have rates of growth about equal to those of hardwoods in the central deciduous forest region of the United States. Brown and Matthews have previously shown that the dipterocarps,

which are the dominant trees at low altitudes in the Philippines, also show similar rates of growth and have pointed out that the rates of growth of the dipterocarps in the Philippines are similar to those of *Shorea robusta* in India.

The great density of the stands in the dipterocarp forests of the Philippines seems to account for the fact that the trees do not grow faster than those in the central hardwood region in the United States. *Parashorea plicata,* on Mount Maquiling, Philippine Islands (figure 1), growing in a rather open stand for a dipterocarp forest, shows much more rapid rates of growth than the average rate for dipterocarps. In Kurseong District, Bengal[7] where the altitudes are low and moisture conditions favorable, *Shorea robusta* grows much more rapidly than in many other districts; the rates of growth being slightly faster than those for *Parashorea plicata* on Mount Maquiling. Caccia found that the rates of growth of *Shorea robusta* decreased at higher altitudes. Brown and Matthews also found that the same was true of trees in the dipterocarp forests of the Philippines. It is a well-known fact that in the tropics, as high altitudes are reached, the trees become very much dwarfed. This dwarfing is due to factors incident to high altitudes, but as the intensity of these factors varies at the same altitudes in different regions, it is not surprising that the degree of dwarfing is by no means proportional to the altitude. On Mount Maquiling at an altitude of 1,050 meters the trees are about 10 meters high, while on the Gedeh at an elevation above 1,300 meters, Doctor Koorders measured a tree 49 meters high. The forest on the Gedeh is more open than the average dipterocarp forest in the Philippines, which might be expected to result in faster rates of growth. On the other hand, the elevation is considerably greater and this is probably accompanied by factors which retard the rates of growth. The large size attained by the trees would, however, indicate that this retarding effect is not nearly so great as in many other regions at the same altitude.

SUMMARY

The rates of growth of the trees on the Gedeh, in the limited number of cases measured, would indicate that these trees grow about as rapidly as the dominant trees in the Philippines, *Shorea robusta* in India, and hardwoods in the central hardwood regions of the United States.

[7] Caccia, A. M. F. A preliminary note on the development of sal in volume and in money-value, *Indian Forest Records* 1 (1908) 1–238.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Comparison of the rates of growth of trees on the Gedeh, Java, with those for trees in other regions.

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FUNGI COLLECTED BY E. D. MERRILL IN SOUTHERN CHINA

By HARRY S. YATES

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The present paper is based upon a small collection of fungi made by Mr. E. D. Merrill while in Kwantung Province, southern China in October and November, 1916. A number of additional specimens were collected, but these were in an immature condition and consequently exact identification has not been possible. The number of specimens considered is too small to indicate very much regarding the composition of the fungus flora of Canton and vicinity. Many of the fungi collected are widely distributed and well-known forms. The rather high proportion of *Uredinaceae* is perhaps suggestive, because in the Philippines the rust fungi are relatively uncommon. It is possible however, that collections made at other seasons of the year would show a much smaller percentage of rusts as the abundance of *Uredinaceae* in a locality often varies greatly from season to season. The presence in the collection of only one of the *Perisporiaceae* is also in rather marked contrast to the relatively great abundance of this group in the Philippine fungus flora where often one-half the lower fungi in a collection belong in this group.

BACTERIACEAE

PSEUDOMONAS Migula

PSEUDOMONAS CITRI Hasse in Journ. Agric. Research 4 (1915) 99.

Kwangtung Province, Canton (Honam Island), *Merrill 10393*, October 1916, on leaves of *Citrus* sp.

The bacterium responsible for the Citrus canker was not found but the general appearance of the infected areas on the leaves is that of this well known organism.

PERISPORIACEAE

PARODIELLA Spegazzini

PARODIELLA PERISPORIOIDES (B. & C.) Speg. in Anal. Soc. Cient. Arg. 9 (1880) 178.

Dothidea perisporioides B. & C. in Grev. 4 (1876) 103.

Kwangtung Province, Canton (Honam Island), *Merrill 10392*, October 23, 1916, on leaves of *Desmodium triflorum*.

PHYLLACHORACEAE

TRABUTIA Saccardo et Roumeguere

TRABUTIA CHINENSE sp. nov.

Stromatibus epiphyllus, in maculis decolorantibus 1–2 mm diam. vel aggregatis et gregis convexulis atris irregularibus usque 1 cm diametro efformante; loculis 1 ad 3, lenticularibus, 250–400μ diam., 100–125μ altis; ascis clavatis, ad apicem rotundatis, octosporis, 60–70 x 18–20μ, breviter stipitatis, paraphysibus filiformibus; sporidiis oblique 1-2-stichis, ellipsoideis, unicellularis, hyalinis, 16–18μ longis, 8–9μ latis.

Kwangtung Province, Loh Fau Mountain (Lofaushan), *Merrill 10410*, October 29, 1916, on leaves of *Ficus* sp.

PHYLLACHORA Nitschke

PHYLLACHORA COICIS P. Henn. in Hedwigia 34 (1895) 12.

Kwangtung Province, Canton (Honam Island), *Merrill 10402*, November 9, 1916, on leaves of *Coix lachryma-jobi.*

PHYLLACHORA CYNODONTIS (Sacc.) Niessl. in Not. Pyren. (1876) 54.

Physalospora cynodontis Delacr. in Bull. Soc. Myc. Fr. 6 (1890) 183.

Kwangtung Province, Canton (Honam Island), *Merrill 10388*, October 26, 1916, on leaves of *Cynodon dactylon.*

PHYLLACHORA ORBICULA Rehm in Elm. Leaf. Philip. Bot. 6 (1914) 2221.

Kwangtung Province, Canton (Honam Island), *Merrill 10405*, November 3, 1916, on leaves of *Bambusa blumeana.*

PUCCINIACEAE

PUCCINIA Persoon

PUCCINIA CYNODONTIS Desm. Exs. III, No. 655; Fuckel, Syn. Myc. Nacht. 1 (1871) 296; Sydow, Monograph Ured. 1 (1904) 748.

Kwangtung Province, Canton (Honam Island), *Merrill 10384*, October 26, 1916, on leaves of *Cynodon dactylon.*

I have not been able to locate the original description of this species, but a diagnosis is to be found in Sydow's Monograph of the Uredinaceae.

PUCCINIA HETEROSPORA B. & C. in Journ. Linn. Soc. Bot. 10 (1868) 356.

Kwangtung Province, Canton (Honam Island), *Merrill 10391*, November 2, 1916, on leaves of *Prunus persica.*

UREDO Persoon

UREDO CANTONENSIS sp. nov.

Soris uredosporiferis hypophyllus, punctiformibus, mox nudis, brunneis, 0.25–0.33 mm diam.; uredosporis globosis vel subglobosis, echinulatis, brunneis, 22–26 x 16–20μ, episporio ca. 1–2μ crasso, poris germinationis 1–3; pedicellis hyalinis, 20–50μ longis, 5–6μ latis.

Kwangtung Province, Canton (Honam Island), *Merrill 10386*, November 3, 1916, on leaves of *Melothria indica*.

This species is one of the few belonging to this genus occuring upon the *Cucurbitaceae*. It appears to be very close to the uredo form of *Uromyces Hellerianus* Arth., described from material from Porto Rico on *Cayaponia racemosa*. No teleutospores have however been found in our material and so it must be described as a *Uredo*.

Uromyces melothriae P. Henn., which according to Sydow is merely a uredo form, differs from our species chiefly in its much larger spore measurements. It was originally described from Abyssinia on *Melothria tomentosa*.

UREDO PHILIPPINENSIS Syd. in Ann. Myc. 4 (1906) 32.

Kwangtung Province, Canton (Honam Island), *Merrill 10404*, October 25, 1916, on leaves of *Cyperus* sp.

UROMYCES Link

UROMYCES LINEARIS B. et Br. in Journ. Linn. Soc. Bot. 14 (1875) 92.

Kwangtung Province, Canton (Honam Island), *Merrill 10401*, October 25, 1916, on leaves of *Panicum repens*.

USTILAGINACEAE

USTILAGO Persoon

USTILAGO CYNODONTIS P. Henn. in Engl. Bot. Jahr. 14 (1891) 369.

Kwangtung Province, Canton (Honam Island), *Merrill 10403*, October 23, 1916, on inflorescences of *Cynodon dactylon*. Also *Levine 761*, May 5, 1917, on the same host.

USTILAGO KOORDERSIANA Bref. Untersuchung. 12 (1895) 132.

Kwangtung Province, Canton (Honam Island), *Merrill 10403*, October 21, 1916, on inflorescences of *Polygonum* sp.

DEMATIACEAE

CERCOSPORA Fresen

CERCOSPORA PERSONATA (B. et C.) Ellis in Journ. Myc. 1 (1885) 63.

Cladosporium personatum B. et C. in Grev. 3 (1875) 106.

Kwangtung Province, Canton (Honam Island), *Merrill 10387*, October 20, 1916, on leaves of *Arachis hypogaea*.

Cercospora personata is the cause of a serious disease of the peanut in the West Indies. It has also been reported from the United States and India, and is abundant on the leaves of peanuts in the Philippines. It is very similar to, and may be identical with, *Septogloeum arachidis* Rac., which causes a very serious disease of peanuts in Java. *Septogloeum arachidis* has also been reported from Ceylon.

HELMINTHOSPORIUM Link

HELMINTHOSPORIUM RAVENELII Curt. in Am. Journ. Sci. Arts II 6 (1848) 352.

Kwangtung Province, Canton (Homan Island), *Merrill 10400*, October 23, 1916, on inflorescences of *Sporobolus elongatus*.

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THE RATE OF GROWTH OF PODOCARPUS IMBRICATUS AT THE TOP OF MOUNT BANAHAO, LUZON, PHILIPPINE ISLANDS

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(*From the College of Liberal Arts, University of the Philippines and Bureau of Science, Manila*)

ONE PLATE AND TWO TEXT FIGURES

Conifers are, as is well known, frequently prominent or even dominant at higher elevations on tropical mountains. *Podocarpus* is one of the more prominent genera, and is widely distributed in both hemispheres; but, according to Foxworthy,[1] it seems to reach its greatest development in the Malayan region. *Podocarpus imbricatus* Blume [2] is one of the most widely distributed coniferous species in this area. Foxworthy gives the following distribution: Java, Sumatra, Celebes, Moluccas, Borneo, Malay Peninsula, Burma, Philippines, and New Guinea. Concerning its distribution in the Philippines he says:

> This is the commonest and most widely distributed species of the family in the Philippines. It covers the tops of many of our mountains. Found at elevations from 900 to 2700 meters.

Owing to its wide distribution and its prominence in many places, *Podocarpus imbricatus* Blume may be considered as a representative conifer of tropical mountains. It may, therefore, be of interest to examine its rate of growth and the condition

[1] Foxworthy, F. W., Philippine Gymnosperms, *Philip. Journ. Sci.* 6 (1911) *Bot.* 149–177.

[2] The form here called *Podocarpus imbricatus* Blume is exactly that characterized by Parlatore as *P. cumingii*. Cuming's specimens were from Mount Banahao. Pilger has reduced Parlatore's species as *Podocarpus imbricatus* Blume var. *cumingii* (Parl.) Pilg., while Foxworthy treats *P. cumingii* Parl. as an exact synonym of *P. imbricatus* Blume.

under which it occurs on Mount Banahao which is a typical locality.

Mount Banahao, on the Island of Luzon, is one of three extinct volcanic cones which form an isolated mountain mass on the boundary between the Provinces of Laguna and Tayabas. Mount Banahao is the largest of the three and has an elevation of about 2,300 meters. The next highest is Mount San Cristobal which lies to the east of Mount Banahao and is connected with the latter by a narrow saddle. The third one, Lukban Peak, is a small cone on the northeastern side of Mount Banahao. All three peaks are regular cones. Mount Banahao has a large crater which is open toward the south. The sides of the crater are very steep, while the rim is narrow and knifelike.

The area in which the rate of growth of *Podocarpus imbricatus* was studied is near the crater rim on the north side of Mount Banahao near the place where the trail from Majayjay reaches the summit. The elevation at this point is about 2,100 meters.

The forest is fairly open and consists of two stories of trees. The first or dominant story is composed almost entirely of *Podocarpus imbricatus*. Besides this species there are a few specimens of *Podocarpus costalis* Presl. The tallest individuals of *Podocarpus imbricatus* reach heights of about 14 meters while the average height of the main canopy is about 12 meters. A large part of the trees have a tendency to lean in a direction away from the slope of the mountain (Plate XVII, figs. 1 and 2). The second story is composed of a few species of dicotyledonous trees the most prominent of which is *Symplocos whitfordii* Brand. Among the other prominent species are *Drimys piperita* Hook. f., *Homalanthus alpinus* Elm., *Clethra lancifolia* Turcz., *Rhododendron kochii* Stein, *Symplocos luzonensis* Rolfe, and *Ilex serrata* Thunb. The undergrowth is scanty and the ground is largely bare. The most important element in the undergrowth is a semiwoody herb, *Strobilanthes pluriformis* C. B. Clarke. In places a small creeping plant, *Nertera depressa* Banks, forms conspicuous patches. Mosses, filmy ferns, and a few liverworts are scattered here and there. Epiphytes are much less conspicuous than on most mountain tops in the Philippines. There are a few mosses on the trees, but they are not prominent. Phanerogamic epiphytes are even less conspicuous than mosses. The most abundant species is a small orchid, *Dendrochilum venustulum* Pfitz.; this plant occurs in considerable numbers in the tops of the trees, and its small yellow flowers are rather showy during the blooming season. *Rhododendron*

quadrasianum Vid., a larger epiphyte, occurs in much smaller numbers.

On the ground there are large numbers of small seedlings of *Podocarpus imbricatus*, but most of the other individuals of this species are more than 10 centimeters in diameter, while trees of *Podocarpus* less than 5 centimeters in diameter are very rare. This would indicate that seedlings of *Podocarpus imbricatus* do not readily survive under a mature stand.

The rainfall on the northern and northeastern slopes of Mount Banahao is distributed throughout all the months of the year, and there are no distinct wet and dry seasons.

The northeast monsoon strikes the Islands on the eastern coast. As there are no high mountain masses northeast of Mount Banahao, this monsoon brings heavy rains to the northern and northeastern slopes of the mountain. The moisture carried by the northeast monsoon is largely deposited on the eastern half of the Islands; and the monsoon continues over the western half of the Archipelago as a drying wind, which results in a marked dry season in the latter region. The southwest monsoon is not nearly so strong as the northeast monsoon, and although it brings rains on the western side of the Archipelago, much of the rain which comes at this season of the year is the result of the cyclonic disturbances (typhoons), which cause the deposition of rains on both sides of the Islands. Therefore, also during this season, heavy rains occur on the northern slopes of Mount Banahao.

Owing to the difficulty of making trips to the top of Mount Banahao to obtain regular records of climatic condition, the writer was compelled to have most of this work done by an assistant, Macario Ocampo, who had had no scientific training. For this reason the only instruments employed were a rain gauge, a recording thermometer, and a recording hygrometer. The results obtained from these are probably about as accurate as would be expected from the instruments as the reading of a rain gauge is very simple and the records from the hygrometer and thermometer were checked by the writer at various times. The hygrometer and thermometer were in a case with louver sides and a lattice bottom and were about 75 centimeters above the ground.

The rain gauge was placed in the top of a dominant *Podocarpus* and was read weekly. The results are given in Table I. An examination of this table shows at once that the rainfall is heavy and is distributed throughout the entire year. The rainfall at

the top of Mount Banahao is much heavier than in the surrounding lowlands, but the distribution is very similar to that for other places on the eastern coast of Luzon. The heavy rainfall results in a constantly high moisture content of the soil.

TABLE I.—*Rainfall in centimeters at the top of Mount Banahao, Luzon, P. I. Altitude, about 2,100 meters.*

Week ending—	Rainfall.	Week ending—	Rainfall.
1915.	*cm.*	1916—Continued.	*cm.*
Nov. 10	8.50	May 17	27.00
17	27.10	24	17.10
24	28.50	31	5.01
Dec. 1	22.10	June 7	14.30
8	16.30	14	13.00
15	14.00	21	6.01
22	9.40	28	9.60
29	30.10	July 5	9.80
1916.		12	26.40
Jan. 5	18.30	19	8.00
12	9.20	26	7.01
19	14.50	Aug. 2	3.45
26	47.60	9	2.20
Feb. 2	59.80	16	4.81
9	0.23	23	4.07
16	10.50	30	3.95
23	15.20	Sept. 6	4.20
Mar. 1	6.50	13	5.11
8	9.50	20	18.40
15	3.15	27	17.80
22	2.65	Oct. 4	21.50
29	15.70	11	7.80
Apr. 5	0.52	18	20.50
12	13.60	25	18.10
19	10.50	Nov. 3[a]	41.20
26	19.80	Total	746.82
May 3	10.10		
10	7.15		

[a] Nine days.

The relative humidity records are presented in Table II in the form of maxima, minima, means, averages of daily maxima, and averages of daily minima of periods of four weeks from November, 1915, to November, 1916. The means for both humidity and temperature were taken from the original records by

means of a planimeter. An examination of Table II would indicate that the humidity at the top of Mount Banahao should be favorable for plant growth.

TABLE II.—*Relative humidity for periods of four weeks in forest at the top of Mount Banahao, Luzon, P. I. Altitude, about 2,100 meters.*

Four weeks ending—	Maximum.	Minimum.	Mean.	Average daily—	
				Maximum.	Minimum.
Dec. 1, 1915	93.0	81.5	89.8	91.1	88.4
Dec. 29, 1915	97.5	85.0	90.1	91.7	88.3
Jan. 26, 1916	94.0	71.0	90.4	91.7	87.2
Feb. 23, 1916	99.0	72.0	91.2	93.6	87.8
Mar. 22, 1916	100.0	51.0	93.0	96.9	86.3
Apr. 19, 1916	100.0	62.0	94.9	97.9	91.0
May 17, 1916	97.0	85.5	92.3	94.9	89.6
June 14, 1916	97.0	87.0	93.1	95.0	91.0
July 12, 1916	99.5	86.0	93.6	96.0	91.7
Aug. 9, 1916	100.0	71.0	91.9	94.7	88.0
Sept. 6, 1916	99.0	79.0	92.5	93.9	89.0
Oct. 4, 1916	100.0	88.5	95.4	96.8	93.8
Nov. 1, 1916	100.0	91.5	96.8	98.2	90.7
Average			92.7	94.8	89.4

In Table III the temperature record is presented in the form of maxima, minima, mean, daily maxima, and average daily minimum for periods of four weeks from October, 1915, to November, 1916. The variations in the mean temperature for the different periods of four weeks are slight, the lowest mean for such a period being 13.2° and the highest, 15.8°. The average daily variation is also slight, the difference between the average maximum and the average minimum for the year being only 2.2°. There are, however, occasions when the temperature varies considerably from the mean. The highest temperature recorded during the year was 23.6° and the lowest, 5°; so that the difference between the maximum and minimum for the year is 18.6°. This variation is small as compared with the variations in temperate regions. The temperature is constantly too low to be favorable for rapid growth at any time.

TABLE III.—*Temperature for periods of four weeks in forest at the top of Mount Banahao, Luzon, P. I. Altitude, about 2,100 meters.*

Four weeks ending—	Maximum.	Minimum.	Mean.	Average daily—	
				Maximum.	Minimum.
Dec. 1, 1915	17.7	10.6	14.9	15.9	13.3
Dec. 29, 1915	17.1	10.0	13.8	14.7	13.1
Jan. 26, 1916	16.5	8.3	13.4	14.6	12.0
Feb. 23, 1916	15.8	7.7	13.2	14.2	12.0
Mar. 22, 1916	17.8	5.0	13.5	15.0	12.2
Apr. 19, 1916	17.1	10.3	13.5	14.5	12.4
May 17, 1916	19.2	11.1	15.0	16.2	13.8
June 14, 1916	18.9	14.3	15.1	17.6	15.2
July 12, 1916	22.7	12.5	15.7	17.4	14.8
Aug. 9, 1916	23.6	9.2	15.2	16.7	14.1
Sept. 6, 1916	19.2	12.2	14.9	16.1	14.6
Oct. 4, 1916	17.1	12.2	15.8	15.6	14.2
Nov. 1, 1916	17.1	14.5	15.6	15.9	14.7
Average			14.6	15.7	13.6

Since no annual growth rings have been observed in the wood of *Podocarpus imbricatus*, the rate of diameter growth can only be determined by making periodical measurements of the girth of the same trunks. On May 29, 1914, the girths of a number of trees of *Podocarpus imbricatus* were measured with a steel tape at breast height, or 1.5 meters above the ground; and that the trees might be again measured at exactly the same point the place of measurement was, in each case, indicated by a small nail. A year later the trees were again measured and the differences between the two measurements taken to be the rates of growth in girth for the year in question. As the climatic condition in Luzon for this year was approximately average, it is probable that the rates of growth obtained for *Podocarpus* are approximately average rates of growth for this species in this locality. The growth figures have been converted into the more usual form of rates of diameter growth. The results are presented in Table IV, in which the trees are classified according to diameter classes of 10 centimeters. In order to approximate the total ages of trees of different sizes, the average annual rate of growth of each 10-centimeter class was divided into 10 centimeters and the quotients assumed to be the number of years necessary for an average tree to pass through the 10-centimeter diameter classes. By summing up these quotients we can obtain a figure which represents the age of an average tree in any 10-centimeter diameter class; that is, the quotient obtained by dividing the annual growth of the

size class from 0 to 10 centimeters into 10 centimeters may be assumed to be the age of a 10-centimeter tree. Adding this quotient to that obtained in a similar manner for the 10- to 20-centimeter class, gives the age of a 20-centimeter tree. In order to obtain figures for the age of trees of any size and to represent the above data in graphic form, a curve of diameter growth on age was constructed by plotting the data on cross-section papers, the ordinates of the curve being diameters and the abscissae, years.

TABLE IV.—*Annual diameter growth of Podocarpus imbricatus at top of Mount Banahao, Luzon, P. I. Altitude, about 2,100 meters.*

[Diameter in growth are given in centimeters.]

No. of tree in class.	Diameter class in centimeters.					
	0–10.		10–20.		20–30.	
	Diameter.	Growth.	Diameter.	Growth.	Diameter.	Growth.
1	7.6	0.06	12.8	0.82	20.7	0.13
2	8.5	0.06	13.4	0.13	21.0	0.09
3			14.1	0.17	21.1	0.09
4			15.4	0.06	21.2	0.22
5			15.9	0.09	21.8	0.03
6			16.0	0.19	21.5	0.35
7			17.2	0.06	21.8	0.06
8			17.8	0.14	22.0	0.22
9			18.1	0.06	22.2	0.03
10			18.3	0.16	22.4	0.06
11			18.7	0.13	22.7	0.19
12			19.0	0.09	23.0	0.35
13			19.4	0.32	23.2	0.14
14			19.6	0.03	23.4	0.19
15					23.5	0.03
16					24.0	0.03
17					24.2	0.19
18					25.0	0.19
19					25.3	0.14
20					25.6	0.13
21					26.4	0.22
22					26.5	0.11
23					26.6	0.09
24					26.7	0.16
25					26.9	0.09
26					27.5	0.35
27					27.8	0.06
28					29.3	0.18
29					29.4	0.09
30					29.5	0.29
Average		0.07		0.14		0.15
Years in class		167		71		67

TABLE IV.—*Annual diameter growth of Podocarpus imbricatus at top of Mount Banahao, Luzon, P. I.—Altitude, about 2,100 meters*—Continued.

No. of tree in class.	Diameter class in centimeters.					
	30–40.		40–50.		50–60.	
	Diameter.	Growth.	Diameter.	Growth.	Diameter.	Growth.
1	30.5	0.09	41.0	0.13	50.9	0.32
2	30.6	0.06			51.9	0.13
3	32.0	0.22			53.1	0.16
4	32.1	0.09			56.1	0.25
5	33.0	0.16				
6	33.2	0.35				
7	33.4	0.19				
8	33.8	0.22				
9	34.8	0.03				
10	36.0	0.16				
11						
12						
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21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
Average		0.16		0.13		0.21
Years in class		62		77		53

This curve is shown in fig. 1. The curve indicates that the trees undergo a suppression period before they reach diameters of 10 centimeters. According to this curve a tree 60 centimeters in diameter has an age of 497 years.

The method used in estimating the age of *Podocarpus* is open to the following objections. All of the trees in the 0- to 10-centimeter diameter class were more than 5 centimeters in diameter, and it is to be expected that they would show a faster rate of growth than smaller and more suppressed individuals. On the other hand some of the trees in the 0- to 10-centimeter diameter classes may be shaded to such an extent that they will die before reaching larger sized diameter classes. Such

trees, would be expected to grow slower than trees, which are now larger, did when they were 5 to 10 centimeters in diameter. It will be seen, therefore, that the age of a 10-centimeter tree cannot be calculated with any considerable degree of accuracy from the present figures. Most of the trees with diameters greater than 10 centimeters are in the main canopy so that any error, due to the fact that some of these may not reach larger sized classes, is probably very small.

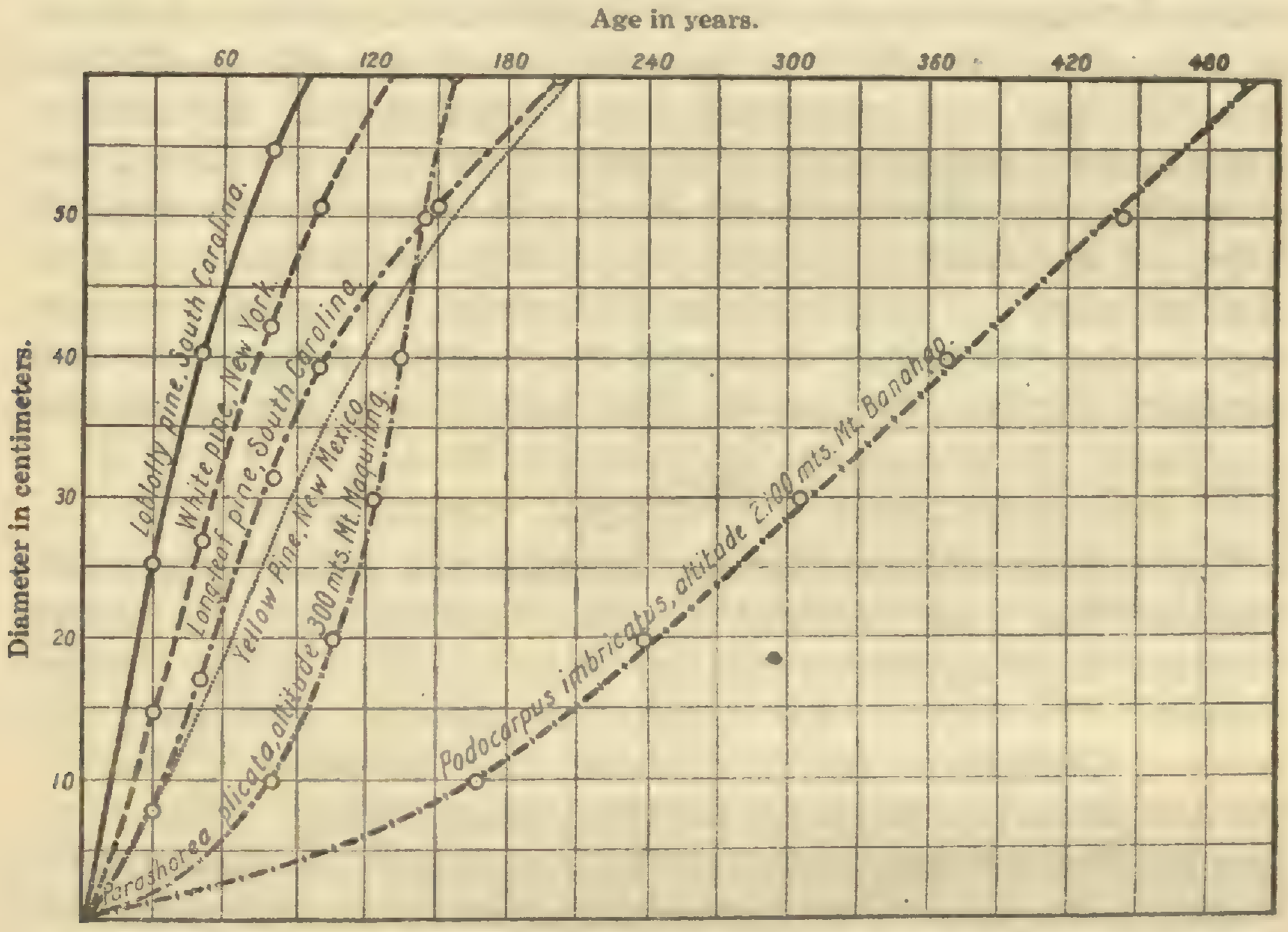

FIG. 1. Rates of growth of *Podocarpus imbricatus* on Mount Banahao and of pines in the United States.

In fig. 1 are also shown curves for loblolly pine[3] in South Carolina, white pine[3] in New York, long-leaf pine[3] in South Carolina, and yellow pine[4] at an altitude of 2,650 meters in New Mexico. It will be seen at a glance that the growth of all of these species is very much more rapid than that of *Podocarpus imbricatus* and that the difference between the rates of growth of the fastest and the slowest growing of these temperate zone species is very much less than the difference between the rate of growth of yellow pine, which shows the slowest growth, and that of *Podocarpus imbricatus*. *Podocarpus imbricatus* when 50 centimeters in diameter appears to be 2.4 times as old as yellow pine

[3] Graves, H. S., and Ziegler, E. A., The woodman's hand book, *Bull. U. S. Forestry Service* **36** (1910) 189–190.

[4] From data collected by Mr. O. F. Bishop in the Carson National Forest in 1911.

with the same diameter and 5.3 times as old as loblolly pine. These figures would indicate that *Podocarpus imbricatus* on Mount Banahao is growing under much less favorable conditions than these different species of pine in the United States.

The moisture conditions on Mount Banahao would appear to be favorable throughout the year, as the humidity is constantly high and the soil is moist.

Unfortunately we have no exact method of comparing the effects of various climatic factors in different regions. A means of estimating the effect of temperature on growth in different localities has been suggested by Livingston and Livingston.[5] They assume that the rate of growth is unity at 40° F. and that it doubles for every rise of 10° C. In other words that the effect of temperature on growth follows the well-known van't Hoff principle. If t is taken as the normal daily mean temperature on the Fahrenheit scale and if u is the corresponding temperature efficiency for growth, then according to the assumption

$$u=2^{\frac{t-40}{18}}.$$

The indices obtained in this manner are called exponential indices. The time element is taken into account by adding together the efficiency indices for all of the days of the frostless season. The results are summation indices. Following this method, Livingston and Livingston have prepared a chart of the temperature efficiencies for the United States. Livingston [6] has devised another series of indices, based on Lehenbauer's work on the relation of temperature to the rate of growth of maize seedlings.

In Table V are given the summation indices for the period of an average frostless season, according to both systems, for New York and South Carolina; also summation indices for a whole year for the top of Mount Banahao. The figures for New York

TABLE V.—*Summation indices of temperature efficiency for plant growth, according to the physiological and exponential systems, for New York, South Carolina, and the top of Mount Banahao.*

	New York.	South Carolina.	Mount Banahao.
Physiological	5,968	16,007	6,016
Exponential	447	884	736

[5] Livingston, B. E., and Livingston, G. L., Temperature coefficients in plant geography and climatology, *Bot. Gaz.* 56 (1913) 349–375.

[6] Livingston, B. E., Physiological temperature indices for the study of plant growth in relation to climatic conditions, *Physiological Researches* 1 (1916) 399–420.

and South Carolina are averages of the figures given by Livingston for stations in these states.

The figures in Table V would not indicate that the temperature at the top of Mount Banahao is more unfavorable for growth than that in the northern United States. Such a conclusion must, however, be regarded as tentative.

Owing to the prevalence of clouds the light conditions at the top of Mount Banahao are very unfavorable. It is usual for mountains on tropical islands to be frequently capped with clouds and the decrease in the intensity of light, due to this, is probably responsible, in a considerable measure, for the rapid dwarfing of vegetation as high altitudes are reached on such mountains. According to Wiesner [7] sunless days are much more frequent at the tops of mountains than at lower altitudes. At the top of Mount Banahao the sun is obscured for a large part of most days, and this is probably a very important factor in causing a slow rate of growth.

In fig. 1 is also shown a curve of growth of *Parashorea plicata* [8] at an altitude of 300 meters on Mount Maquiling. This curve shows that the small individuals of *Parashorea* undergo a suppression period, but that after this period is passed *Parashorea* grows much more rapidly than any of the four species of pines whose growth curves are given in the same figure, and very much more rapidly than *Podocarpus imbricatus*.

In Table VI the rate of growth of *Podocarpus imbricatus* is compared with the rates of growth of some species of dipterocarps growing at low altitudes in the Philippines.[9] This relation

TABLE VI.—*Rates of growth of Podocarpus imbricatus on Mount Banahao as compared with rates of other species in the Philippines.*

[Figures represent annual diameter growth in centimeters.]

Species.	Location.	Altitude.	Diameter class in centimeters.					
			5–10.	10–20.	20–30.	30–40.	40–50.	50–60.
		Meters.						
Parashorea plicata	Mount Maquiling	300	0.28	0.40	0.62	0.92	0.88	0.88
Shorea teysmanniana	Northern Laguna	500	0.27	0.38	0.57	0.50	0.54	0.43
Shorea polysperma	do	500	0.27	0.27	0.40	0.37	0.55	0.34
Shorea squamata	do	500	0.32	0.28	0.35	0.28	0.42	0.26
Shorea polysperma	Mount Mariveles	400–500	0.13	0.26	0.36	0.52	0.41	------
Dipterocarpus grandiflorus.	do	400–500	0.07	0.16	0.19	0.16	0.16	0.22
Podocarpus imbricatus	Mount Banahao	2,100	0.06	0.14	0.15	0.16	0.18	0.21

[7] Wiesner, J. Der Lichtgenuss der Pflanzen (1907).

[8] Brown, W. H., and Matthews, D. M., Philippine dipterocarp Forests, *Philip. Journ. Sci.* A, 9 (1914) 413–561.

[9] Brown, W. H. and Matthews, D. M., loc. cit.

is shown graphically in fig. 2. The dipterocarps, like *Podocarpus imbricatus*, are dominant trees. It will be seen at once that five of the different species of dipterocarps show rates of growth which are very much more rapid than that of *Podocarpus imbricatus*. The sixth, *Dipterocarpus grandiflorus*, also shows a faster rate of growth than *Podocarpus imbricatus*. Fig. 2 would seem to indicate that the rate of growth of the average dipterocarp is about 2.5 times as rapid as that of *Podocarpus imbricatus* at the top of Mount Banahao, which is not surprising

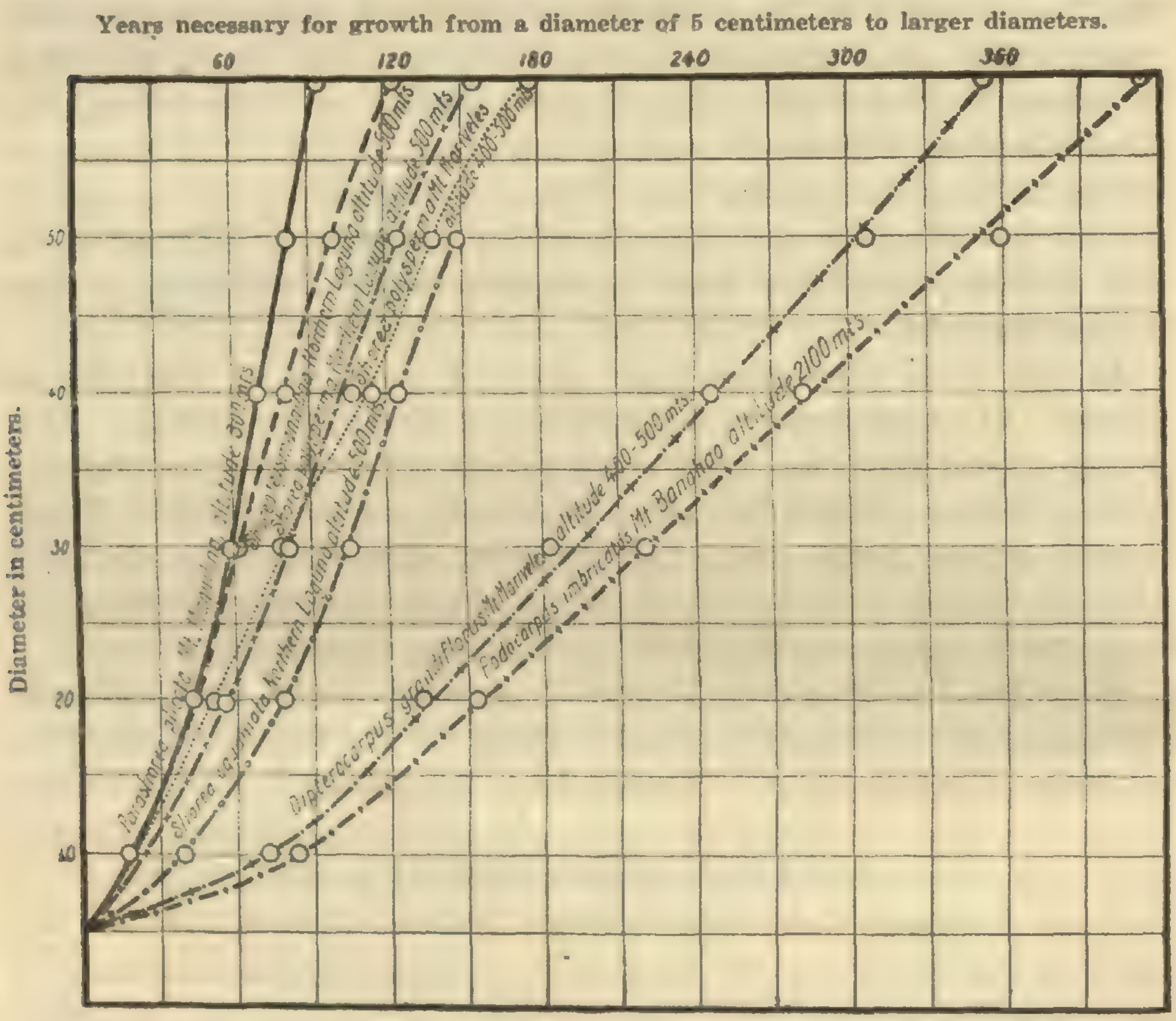

FIG. 2. Rates of growth of *Podocarpus imbricatus* on Mount Banahao and of dipterocarp species in other parts of the Philippines.

in view of the fact that *Podocarpus* is subjected to conditions of temperature and light that are very unfavorable as compared with those under which the dipterocarp species are found.

CONCLUSIONS

Podocarpus imbricatus at the top of Mount Banahao shows a very slow rate of growth, a tree 60 centimeters in diameter being about 500 years old. The rate of growth of *Podocarpus* is very much slower than that of dominant trees at lower elevations in the Philippines and of pines in the United States.

ILLUSTRATIONS

PLATE XVII

FIG. 1. A view in the forest near the top of Mount Banahao. The prominent trees are *Podocarpus imbricatus*. Note the slant of the trees. Some epiphytes are seen on the trunks but they are much less prominent than is usual on mountain tops in the Philippines.

2. Another view in the forest near the top of Mount Banahao. The large trees are *Podocarpus imbricatus*. The undergrowth appears denser than it really is, due to the fact that the picture was taken on a foggy day and that the perspective is poor.

TEXT FIGURES

FIG. 1. The rates of growth of *Podocarpus imbricatus* on Mount Banahao and of pines in the United States.

2. The rates of growth of *Podocarpus imbricatus* on Mount Banahao and of dipterocarp species in other localities in the Philippine Islands.

Fig. 1. Forest of Podocarpus imbricatus.

Fig. 2. Forest of Podocarpus imbricatus.

PLATE XVII.

THE PHILIPPINE JOURNAL OF SCIENCE, C. BOTANY.
Vol. XII, No. 6, November, 1917.

THE GENUS CHRISTIOPTERIS

By EDWIN BINGHAM COPELAND

This genus was described by me in 1915.[1] The original description is in error in the spelling of the generic name, which was written *Christiopteris*, and in the statement that there are no paraphyses. In reality, there are present few and small paraphyses, sometimes branched near the head. The type species, *Christiopteris Sagitta* Copel., was originally described by Christ from sterile material, as a *Polypodium* of the section *Phymatodes*. Superficially, this sterile frond certainly suggests relationship to *Phymatodes* so strongly that its reference to that group is easily understood. On the basis of its fruiting characters, I first ascribed to the fern a position in the subtribe *Taenitideae*, next to *Drymoglossum*.

A little later, I was fortunate enough to find fruiting material in the neighborhood from which Christ's sterile specimens had come, and published a photograph of this.[2] At about the same time, sterile material from Rizal Province, Luzon, was sent to Christ, who was disposed to regard it as a distinct species; similar fronds from Mount Apo, Mindanao, have the same form. It has never been found fertile in Mindanao, although I have since found it sterile on Mount Matutum also. Mindanao specimens are characterized by short, relatively rounded lobes of the sterile frond; but as the sterile fronds of Luzon plants which are not yet adult pass through such a stage, it is safer for the present to regard all Philippine specimens as belonging to the one species.

The genus is characterized by dimorphous fronds, the fertile strongly contracted, the fructification acrostichoid but not reaching to midrib or margin. The sporangium-bearing region, which may properly be called a hymenium, is rather more vigorous over the veinlets, but extends without a break over the parenchyma. The veinlets of the sterile frond anastomose freely, in the manner very familiar in *Phymatodes*, *Drynaria*, etc., with the characteristic branched included free veinlets. The annulus is of about 14 cells, and the spores are reniform or bilateral, never tetrahedral.

The next publication on this genus was by Christ.[3] Christ

[1] Perkins, J., Frag. Fl. Philip. (1905) 188.
[2] Philip. Journ. Sci. 1, (1906) Suppl. *pl. 13*.
[3] Journ. de Bot. II 1 (1908) 24.

here recognizes four species which in the order of their vegetative development, the most amply developed first, are:

1. **C. Eberhardtii** Christ.
2. **C. tricuspis** (Hooker) Christ.
3. **C. Sagitta** (Christ) Copel.
4. **C. cantoniensis** (Baker) Christ.

The sterile frond of *C. Eberhardtii* is large and five lobed. The fertile frond is unknown. In this paper, Christ suggests the relationship of *Christiopteris* and *Cheiropleuria.*

Bower [4] has recently made a very careful anatomical study of the fern hitherto best known as *Leptochilus tricuspis* (Hooker) C. Chr. but which he calls "*Gymnopteris* (*Leptochilus*) *tricuspis* (Hook.), C. Chr.," a name which may surprise Christensen. From his summary, I quote:

> 3. L. tricuspis stands alone in the latter genus (Leptochilus) in various features, but especially in the diplodesmic character. It should, therefore, be removed, and by reviving its old generic name, now merged in Leptochilus, it may be styled Gymnopteris tricuspis (Hook.), Bedd. Of that genus it will be at present the only species.

The name which Bower attempts to revive could not possibly stand as valid; but there is still no necessity for a new name, as that already cited, given by Christ and listed in the Supplement to Christensen's Index, is certainly correct.

As noted by Bower, Mrs. Schumann [5] has grouped together *Leptochilus tricuspis* and *L. varians* (Mett.) Fournier, a fern known only in New Caledonia, noting that both have bilateral spores. The herbarium of the Bureau of Science has a number of specimens of the latter species, which struck me several years ago as by no possibility belonging in *Leptochilus*, and as probable relatives of *Christiopteris.* Bower's paper has stimulated me to investigate this more carefully. There is a special bundle system underlying the sporangia, but this is not at all sharply distinguished, in the fronds studied, from the general bundle system nearer the upper surface of the frond, which is homologous to the bundle system of the sterile frond. There are many small paraphyses which are always or nearly always simple. The paleae of the rhizome are ovate, with many or several border cells with thin walls, without trichome-like outgrowths, and not at all reddish in color.

A similar examination of *Christiopteris Sagitta* has shown

[4] Studies in the Phylogeny of the Filicales, VI. Ferns showing the 'Acrostochoid' condition, with special reference to dipteroid derivatives, *Ann. Bot.* 21 (1917) 1–39.

[5] Die Acrosticheen und ihre Stellung im System der Farne, *Flora* 108 (1915) 201–260.

that, as already stated, there are small paraphyses, simple or branched. A special bundle system is present under the hymenium, apparently less developed and distinct than in *C. tricuspis*, but more distinct than in *Leptochilus varians*. The paleae are peltate at the base but drawn out until they have the appearance of harsh hairs, reddish-brown in color, with only the marginal walls of the marginal cells distinctly thin, and with many short marginal hairs, which are not cut off by a wall. The agreement in these anatomical details with those of *C. tricuspis*, as described by Bower, is so perfect that Christ's judgment in uniting the species under one genus is completely vindicated.

The case of the New Caledonia plant is not quite so clear. The paleae are decidely distinct, the only real suggestion of similarity being that the cells near the margin are thinner walled than those at the base and axis of the paleae; and in this respect, they are like the paleae of a considerable number of ferns in genera probably belonging to the same phylogenetic group. Since it most certainly should not be left in *Leptochilus*, and I do not care to distinguish it as a genus characterized by the paleae alone but otherwise like *Christiopteris*, it may be known as CHRISTIOPTERIS VARIANS (*Acrostichum varians* Mett. in Ann. Sci. Nat. IV 15 (1861) 56.)

The genus *Christiopteris*, as now constituted, includes one species in the Himalayas, one in Siam, one in southern China, one in the Philippines, and one in New Caledonia, a discontinuous distribution extending over practically the whole extent of the Malay-Asiatic fern region and indicating, with a high measure of probability, a very considerable antiquity. As the ferns of the intervening regions become better known, it will almost certainly develop that the distribution is by no means as discontinuous as it now appears. In the Philippines, in the course of more than a decade of steady work by a number of good fern collectors, sterile fronds have been found once each on five different mountains, while fertile fronds are still known only from one spot on Mount Mariveles and one collection on Mount Data. A group which has eluded collectors so successfully in the Philippines may be widespread in such little-known regions as New Guinea, Celebes, Borneo, and Sumatra, and have been overlooked in the past.

Bower's previous note [6] had already suggested a likely origin of *Christiopteris*, *Photinopteris*, *Cheiropleuria*, and various groups recognized as *Polypodium* or its relatives, all as probable descendants of the ancient group, the characteristics of which

[6] Studies in the Phylogeny of the Filicales, V, *Ann. Bot.* 19 (1915) 475.

are more perfectly preserved today by *Matonia* and *Dipteris*. His last paper goes into this subject more thoroughly and more conclusively. In field work, during all my years in this part of the world, I have been constantly struck by the common occurrence of dichotomy as a sort of monstrosity of the fronds of *Polypodium*, using the name now in the broad sense in which it is used, for example, in the Natürliche Pflanzenfamilien. While occasional forked fronds are found in the ferns of almost every group, they are rare in most groups, and relatively very common in this one. If I were to go over the very large collections in Manila, mounted and unmounted, I do not believe that I would find dichotomous fronds of less than 75 species which at present bear the generic name *Polypodium*. In some of these it is common enough to be characteristic, as in *P. ceratophyllum* Copel. of Borneo, and *P. Curranii* Copel. of Luzon. Now that the probability has been established, on wholy different grounds, that these ferns are descendants from a group characterized by dichotomy, the occurrence of such fronds in many different species should be regarded as valid contributary evidence.

In search of further points of connection and possible primitive groups, I have examined a number of ferns with regard to the characters emphasized by Bower. *Polypodium incurvatum* Blume is strikingly suggestive of *Christiopteris* in form of sterile fronds and is somewhat dimorphous. Its annulus has 14 or 15 cells. The spores are bilateral and tuberculate. It has a distinct hypodermis, but this is by no means as sharply and conspicuously developed as is true of most species of the *Phymatodes* group. In *Christiopteris* it is still less developed, although the layer immediately under the upper epidermis is somewhat different from the deeper-lying cells of the mesophyll. The paleae of *Polypodium incurvatum* are stout and peltate, not much drawn out to a point, with apparently entire margin (my material is old), almost all walls thin and not colored, except near the base, where the paleae are several cells thick. The points of resemblance to *Christiopteris* are not very significant.

Polypodium Curranii Copel. is a member of the group of *P. myriocarpum* Mett., distinguished by Fée under the generic name *Microsorium*. The paleae are acuminate with the marginal cells alone thin; they are entire or with obscure teeth formed by projections of the walls between cells.

Drymoglossum carnosum J. Sm. has reniform spores and an annulus of 14 cells. The elongate sorus is supplied by a single bundle which is nearer the nether surface of the leaf than are the other bundles of the same frond. The paleae are peltate

or sagittate, caudate, with the marginal walls alone thin and with small teeth, which, however, have thick middle walls, being formed by the joint projection of two marginal cells and the wall between them.

Cyclophorus angustatus Desv., a species notable for its elongated sori, has a single bundle layer under the sorus. The spores are bilateral and the annulus is of 14 or 15 cells. The paleae are long and slender, but not caudate, entire and without very thin walls, although colorless except near the base. The hypodermis is of very large cells which are not very irregular.

Photinopteris speciosa J. Sm. has an obvious and irregular hypodermis not essentially different from that characteristic of the *Phymatodes* group. Its spores are bilateral and the annulus is of about 13 cells. The leaf is much compressed under the sorus, without room for more than one bundle in a layer. The paleae are peltate, but immediately narrowed to a long, harsh, hair-like point. The marginal wall is usually thin, with very peculiar teeth. The smaller of these are like those of *Drymoglossum* and *Hymenolepis;* but there are present also others in which the teeth elongate, one of the cells sometimes outgrowing the other; or both cells may elongate, and separate in the outer part. *Photinopteris* has enough characters in common with *Christiopteris* so that their general affinity is unmistakable; although, as Bower has already shown, Christ's suggestion that they may have eventually to be united is untenable. On the other hand, *Photinopteris* is likewise unmistakably a relative of the *Phymatodes* group; this is the only construction which I can place on the presence in both of the peculiar layer of cells under the upper epidermis.

Aglaomorpha pilosa Copel. (*Dryostachyum pilosum* J. Sm.) has reniform spores and setose sporangia with an annulus of 14 or 15 cells. The lamina under the hymenium is very thin, without room for a diplodesmic vascular supply. The paleae are peltate at the base, and lanceolate, with the walls gradually becoming thinner toward the margin. The margin itself is lacerate-ciliate by separation from the body of the scale of the upper ends of the marginal cells. The hypodermis, already figured in my paper on comparative ecology,[7] has the *Phymatodes* characteristics.

The affinity of *Photinopteris speciosa* J. Sm. and *Aglaomorpha pilosa* Copel. is unmistakable. The most peculiar characteristic of *Photinopteris* is probably the isolated gland below the base of each pinna. *Aglaomorpha pilosa* has likewise a glandular

[7] Philip. Journ. Sci. 2 (1907) *Bot. 3, fig. 36.*

spot on the lamina, immediately below the insertion on the main rib of the rib of each segment. The glands of the two ferns are unmistakably homologous. The two are alike also in being pubescent, although the pubescence itself is not identical. Both also commonly bear lime-dots on the upper surface of young fronds. *Aglaomorpha pilosa,* however, is still more nearly related to *A. splendens* Copel. (*Dryostachyum splendens* J. Sm.); I do not doubt at all the propriety of keeping these two species in one genus and maintaining *Photinopteris* as a separate genus. *Aglaomorpha* as a whole is likewise an unmistakable member of the *Drynaria* group of genera and nearly related to individual species currently regarded as belonging in *Polypodium.* It is interesting, in this connection, to note that the fern originally described by Hooker as *Acrostichum drynarioides,* for which I have created the genus *Merinthosorus,* has been included in *Dryostachyum* (which I consider inseparable from *Aglaomorpha*) by Kuhn, and in *Photinopteris* by Beddome.

In conclusion, it may be observed that we are dealing with a considerable number of ferns, all of which can be regarded almost with certainty as descendants of a common group less remote than their common ancestor with other *Polypodiaceae,* a group to which Bower has given the name of *Dipterideae,* but which I would prefer to call *Matonieae.* Different members of this group share such characters as the tendency to dichotomy; drynarioid venation; harsh hair-like paleae; thin, marginal walls of paleae; reddish color of paleae; peculiar teeth on the paleae; round, elongate or indefinite collections of sporangia not reaching the margin; annulus of about 14 cells; bilateral spores; diplodesmic venation beneath the hymenium; and a peculiar hypodermis underlying the upper epidermis. Different groups of species and of genera have maintained different collections of these characters. Unless one character be very distinctive and restricted to few species, as in the case of the peculiar gland of *Photinopteris,* single characters can hardly be trusted to show particular affinities within this great group. It seems to me, however, that the number of characters exhibited by *Platycerium, Cheiropleuria, Christiopteris, Hymenolepis, Drymoglossum, Cyclophorus, Photinopteris, Aglaomorpha, Merinthosorus, Dendroconche,* and the paleotropic Polypodia with anastomosing veins, and *Dipteris, Matonia,* and *Phanerosorus* amply justifies regarding these as a group distinct from the other very large group of *Polypodiaceae* which are descendants of an old group now best represented by *Balantium, Dicksonia, Dennstaedtia, Cystodium,* and *Cyathea.*

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NEW PHILIPPINE MELASTOMATACEAE

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At the commencement of our botanical exploration of the Philippines in 1902, but a few representatives of this characteristic family were known from the Archipelago. The number of genera is not large, representatives of but about twenty-one being now known from the Philippines; by far the largest genus is *Medinilla*, while *Astronia* and *Memecylon* are both represented by a fair number of species. With the exception of a few of the more common and widely distributed species most of the representatives of this family are confined to the forested areas, and a very high percentage of them are not only endemic, but are also very local. I have previously published two papers[2] devoted entirely to representatives of this family, chiefly to the genera *Astronia*, *Memecylon*, and *Medinilla*. The present paper is in the nature of a continuation of the former ones and consists chiefly of the descriptions of twenty-eight new species in the genera *Anerincleistus*, *Astronia*, *Medinilla*, *Melastoma*, *Otanthera*, and *Memecylon*, with a new variety of *Beccarianthus ickisii* Merr.; the genus *Anerincleistus* is new to the Philippines.

ANERINCLEISTUS Korth

ANERINCLEISTUS PHILIPPINENSIS sp. nov.

Frutex 2 ad 3 m altus; ramulis dense pilosis; foliis oppositis, in eisdem paribus inaequalibus sed similimis, ovatis, chartaceis, acuminatis, denticulatis, basi cordatis, 7- vel 9-nerviis usque ad 20 cm longis, utrinque plus minusve hirsutis vel hispido-pilosis; floribus axillaribus, solitariis vel fasciculatis, pedicellatis, petalis circiter 1.5 longis.

An erect, branched shrub 2 to 3 m high, most parts more or less densely pubescent. Branches terete, rather slender, densely pilose with short, spreading, brownish or purplish hairs. Leaves in pairs, unequal but similar in shape, ovate, 10 to 20

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[2] Merrill, E. D., Studies on Philippine Melastomataceae, I, *Philip. Journ. Sci.* 8 (1913) Bot. 207–250; II, op. cit. 335–361, *pl. 11, 12.*

cm long, 6 to 15 cm wide, base broad, cordate, apex rather sharply acuminate, margins denticulate, the upper surface somewhat hispid-pubescent, the hairs dense on the nerves, otherwise scattered, short, the lower surface paler, more densely and softly pubescent; nerves 7 to 9 from the base, the inner 5 more prominent than the others and reaching to the apex, often reddish; transverse veinlets subparallel, prominent, distant, the reticulations lax; petioles densely pubescent, 2.5 to 9 cm long. Flowers pink-purple, axillary, solitary or fascicled, their pedicels densely pubescent, 1 to 1.5 cm long. Calyx ovoid, densely hirsute with spreading hairs, about 1 cm long, 8 mm thick, the lobes 4, oblong-lanceolate, acuminate, about 9 mm long, 4 mm wide, hirsute on both surfaces, ultimately deciduous. Petals elliptic-oblong or oblong, equilateral, glabrous, shortly and slenderly apiculate-acuminate, base somewhat narrowed, about 1.5 cm long, 11 mm wide. Stamens 8, subequal; filaments 1 cm long; anthers inflexed in bud, lanceolate, acuminate, somewhat curved, 9 to 10 mm long, opening by a terminal pore, the connective not produced, not appendaged in front, the posterior appendage at the base very short, stout, obtuse, less than 0.3 mm long. Ovary glabrous, somewhat urceolate, nearly or at least one-half free, 4-celled, apex with a somewhat produced, irregularly denticulate but scarcely lobed margin; style about 2 cm long, slender; stigma punctiform. Capsule about 6 mm long, glabrous, but surrounded at the base by the densely hirsute, persistent calyx-tube, 4-valved, concave at the apex, the valves somewhat thickened upward, their apices obliquely truncate, about 2 mm broad. Seeds numerous, oblong-obovate, 0.5 mm long, apex truncate, minutely verruculose.

PALAWAN, Malampaya Bay, in thin forests at an altitude of from 2 to 5 meters, on hillsides near the sea, *Merrill 7241* (*Phil. Pl. 408*), September 18, 1910, *Merrill 9412*, May, 1913; Mount Capoas, *Merrill 9552* April 21, 1913.

The first representative of the genus to be found in the Philippines, differing from all described ones especially in its large flowers. The type of the genus, *Anerincleistus hirsutus* Korth., and most of the known species have very small flowers, but in *A. macranthus* King, of the Malay Peninsula, the flowers are nearly as large as in the present species. The genus has about ten known species, other than the one above described, in Borneo, Sumatra, the Malay Peninsula, and Burma.

ASTRONIA Noronha

ASTRONIA CONSANGUINEA sp. nov. § *Euastronia.*

Species *A. verruculosae* affinis, differt foliis multo majoribus, usque ad 25 cm longis. Arbor parva, circiter 6 m alta, novellis ferrugineo-furfuraceis exceptis glabra; bracteis magnis, oblongis

ad oblongo-ovatis, 12 ad 15 mm longis; floribus infundibuliformibus, 5-meris, calycis glabris vel obscurissime furfuraceis, circiter 4 mm longis, 6 mm diametro.

A tree about 6 m high, ultimately glabrous, the very young growing parts prominently ferrugineous-furfuraceous. Branches brown, terete, rugose, about 6 mm in diameter. Leaves subcoriaceous, green and of about the same color on both surfaces when dry, minutely and densely verruculose, dull or slightly shining, oblong-elliptic, 20 to 25 cm long, 7 to 10 cm wide, narrowed below to the very prominently 3-nerved cuneate base, the apex rather abruptly and slenderly acuminate, the acumen obtuse, about 1 cm long, glabrous on both surfaces, or the nerves on the lower surface minutely and obscurely lepidote; lateral longitudinal nerves about as prominent as the midrib, the marginal pair about as distinct as are the transverse nerves and 2 to 4 mm from the edge of the leaf; petioles stout, 5 to 6 mm long, narrowly winged, when very young somewhat furfuraceous, becoming glabrous. Panicles terminal, peduncled, many flowered, about 8 cm long, sometimes branched from the base, sparingly appressed furfuraceous-lepidote. Flowers white or pink, crowded at the apices of the branchlets, 5-merous, the subtending bracts conspicuous, oblong to oblong-ovate, 12 to 15 mm long, concave, subcoriaceous, dark-colored when dry, slightly lepidote or nearly glabrous. Staminate flowers funnel-shaped, the calyx-tube about 4 mm long, 6 mm in diameter, glabrous or very obscurely lepidote, the teeth 5, broad, blunt. Petals 5, orbicular-obovate, 5 to 6 mm in diameter.

LUZON, Tayabas Province, Infanta-Siniloan trail, *Bur. Sci. 29215 Ramos & Edaño*, June 12, 1917, in forests along small streams.

The alliance of this species is manifestly with *Astronia verruculosa* Merr., from which it is readily distinguished by its very much larger leaves and smaller, glabrous or nearly glabrous flowers.

ASTRONIA PACHYPHYLLA sp. nov. § *Euastronia.*

Frutex 2 ad 4 m altus, glaber vel subglaber, ramis ramulisque incrassatis, obscure 4-angulatis vel subteretibus; foliis crasse coriaceis, ellipticis ad obovato-ellipticis, usque ad 9 cm longis, in siccitate utrinque minutissime verruculosis, olivaceis vel brunneo-olivaceis, concoloribus, basi cuneatis, prominente 3-nerviis, apice abrupte et brevissime apiculatis; paniculis terminalibus, usque ad 8 cm longis, pedunculatis; floribus plus minusve confertis, 4-meris; bracteis oblongo-ovatis, obtusis, usque ad 9 mm longis; calycis circiter 4 mm longis et 5 mm diametro, glabris vel subglabris, dentibus late triangularibus, circiter 1.5 mm longis.

A shrub 2 to 4 m high, nearly glabrous. Branches and branch-

lets thickened, obscurely 4-angled or subterete, the branches 5 to 8 mm in diameter, brown, glabrous, somewhat rugose when dry, the internodes 7 to 20 mm long. Leaves thickly coriaceous, olivaceous or brownish-olivaceous when dry, of about the same color on both surfaces, minutely and densely verruculose, glabrous, elliptic to obovate-elliptic, 5 to 9 cm long, 2.5 to 4.5 cm wide, base cuneate, prominently 3-nerved, the apex abruptly and shortly apiculate, the apiculus stout, blunt; the lateral pair of longitudinal nerves about as prominent as the midrib, extending from the base to the apex, a faint marginal pair at about 1 mm from the edge of the leaf, the transverse nerves numerous, distinct; petioles dark-brown, 1.5 to 2.5 mm long. Panicles terminal, peduncled, up to 8 cm in length, glabrous, or when young very sparingly furfuraceous, soon becoming glabrous, the scales thin, appressed, scattered. Flowers white, 4-merous, crowded at the apices of the branchlets, the subtending bracts oblong-ovate, obtuse, up to 9 mm in length, coriaceous, glabrous or obscurely furfuraceous, the bracteoles linear. Calyx-tube cup-shaped, at anthesis about 4 mm long and 5 mm in diameter, the teeth broadly triangular, about 1.5 mm long, glabrous or nearly so. Petals 4, obovate, 4 to 5 mm long.

LUZON, Tayabas Province, Mount Binuang, back of Infanta, *Bur. Sci. 28558* (type), *28695 Ramos & Edaño*, May, 1917, in forests near the summit, altitude about 1,000 meters.

This characteristic species strongly resembles *Astronia verruculosa* Merr., from which it is readily distinguished by its smaller 4-merous flowers and glabrous calyces; the leaves are also somewhat smaller and are abruptly and shortly apiculate at the apex, not acuminate. A single specimen from Mount Calinigan, Camarines Province, Luzon, collected by *D. P. Miranda*, April 24, 1914, greatly resembles the present species but differs in having shorter petioles, prominently 5-nerved leaves, and conspicuously setose-furfuraceous inflorescences.

ASTRONIA PAUCIFLORA sp. nov. § *Euastronia*.

Species *A. subcaudatae* similis et ut videtur affinis, differt ramis ramulisque laevis, castaneis, foliis crassioribus, basi 3-nerviis, utrinque minutissime verruculosis, reticulis ultimis obscuris, paniculis brevioribus, floribus confertis. Frutex 2 ad 3 m altus, partibus junioribus et inflorescentiis castaneo-lepidotis vel furfuraceo-lepidotis; foliis coriaceis vel subcoriaceis, ellipticis, usque ad 8 cm longis, utrinque subaequaliter angustatis, acuminatis, basi acutis, 3-nerviis; paniculis terminalibus, circiter 3 cm longis, paucifloris, floribus confertis, 5-meris.

A shrub 2 to 3 m high, the younger parts and inflorescences castaneous-lepidote or furfuraceous-lepidote, otherwise nearly glabrous. Branches and branchlets slender, terete, castaneous,

smooth, glabrous, the ultimate ones 1.5 to 2 mm in diameter. Leaves coriaceous or subcoriaceous, elliptic, equally narrowed to the acute base and acuminate apex, 6 to 8 cm long, 2.5 to 3 cm wide, greenish or brownish when dry, dull or slightly shining, of about the same color and minutely verruculose on both surfaces, glabrous or very sparingly lepidote along the nerves on the lower surface, the base acute or decurrent-acuminate, prominently 3-nerved, the nerves extending to the apex, the apex rather prominently acuminate; transverse nerves slender, the ultimate reticulations indistinct; petioles glabrous, 1 to 1.5 cm long. Panicles terminal, about 3 cm long, castaneous-lepidote or furfuraceous, few-flowered, the flowers crowded on the ultimate branchlets, 5-merous. Bracts membranaceous, sparingly lepidote, oblong to oblong-ovate, 3 to 4 mm long. Calyx-tube about 3 mm long, sparingly furfuraceous, cup-shaped, the lobes somewhat reniform, about 1 mm long. Petals orbicular, pink to white, 3 mm in diameter.

LUZON, Tayabas Province, Mount Binuang, back of Infanta, *Bur. Sci. 28646* (type), *28780 Ramos & Edaño*, May, 1917, in forests, altitude apparently about 1,000 meters.

This species is manifestly allied to *Astronia subcaudata* Merr., the type of which was from the same locality. It is distinguished from that species especially in its thicker and verruculose leaves which are 3-nerved rather than 3-plinerved; by its castaneous, smooth branchlets; and by the ultimate reticulations of the leaves being very obscure, not conspicuous as is *A. subcaudata*.

ASTRONIA TETRAGONA sp. nov.

Arbor circiter 10 m alta, ramulis ultimis crassis, circiter 1 cm diametro, distincte 4-angulatis vel junioribus anguste 4-alatis, dense minuteque cupreo-lepidotis; foliis ellipticis, usque ad 28 cm longis, acuminatis, basi acutis, perspicue triplinerviis, supra glabris, pallide viridis, subtus uniformiter et dense lepidotis, pallide brunneis; paniculis circiter 15 cm longis, pyramidatis, e basi ramosis, floribus in ramulis ultimis subglomeratim confertis.

A tree about 10 m high, the branches stout, distinctly 4-angled, the ultimate ones about 1 cm in diameter, the younger ones sometimes distinctly 4-winged, all parts densely and minutely cupreous-lepidote. Leaves firmly chartaceous or subcoriaceous, brittle when dry, elliptic, 20 to 28 cm long, 12 to 18 cm wide, acuminate, base acute, prominently 3-plinerved, the upper surface pale greenish when dry, shining, glabrous, without cystoliths, the lower surface densely and uniformly lepidote with small, pale-brownish scales; basal nerves leaving the midrib at from 1 to 1.5 cm above the base, very prominent, extending quite or nearly to the apex, a faint secondary pair present close

to the margin, but these marginal nerves not more prominent than the reticulations; lateral nerves spreading, about 25 on each side, prominent; petioles densely lepidote, 5 to 7 cm long. Panicles terminal, pyramidal, about 15 cm long, branched from the base, the branches few, stout, spreading, the lower ones sometimes 12 cm in length, the others shorter, all parts densely lepidote. Flowers rather densely crowded on the ultimate branchlets, subglomerate, 5-merous, cup-shaped, their pedicels about 2.5 mm long. Calyx about 4 mm in diameter, the teeth very short, broad.

MINDANAO, Lanao District, Lanao-Cotabato trail, *For. Bur. 25204 Alvarez* (type) March 21, 1916, in dipterocarp forests, altitude about 1,000 meters, locally known as *paera*. LUZON, Benguet Subprovince, Baguio, *Sandkuhl 240*, July and January, 1915, *For Bur. 26104 Garcia*, June, 1914: Abra Province, Mount Posuey, *Bur. Sci. 26993 Ramos*, February, 1917.

A characteristic species allied to *Astronia platyphylla* Merr., from which it is easily distinguished by its prominently 4-angled branches and branchlets.

ASTRONIA VERRUCULOSA sp. nov. § *Euastronia*.

Arbor parva, partibus junioribus inflorescentiisque exceptis glabra vel subglabra; foliis coriaceis, in siccitate utrinque minute et dense verruculosis, glabris vel subtus parcissime lepidotis, oblongo-ellipticis, usque ad 15 cm longis, utrinque subaequaliter angustatis, apice acuminatis, basi acutis, 3-nerviis; paniculis circiter 7 cm longis, furfuraceis; floribus magnis, 5-meris, circiter 6.5 mm longis, calycis urceolatis, circiter 6 mm diametro, extus lepidotis vel furfuraceo-lepidotis.

A tree about 7 m high, glabrous except the younger parts, the petioles and the inflorescences. Branches glabrous, wrinkled when dry, somewhat brownish-red, the branchlets more or less brown-furfuraceous. Leaves rather thickly coriaceous, dull, of about the same color, and pale yellowish-green on both surfaces when dry, oblong-elliptic, 10 to 15 cm long, 3 to 6 cm wide, when dry both surfaces minutely and densely verruculose, entirely glabrous, or the lower surface, when young, with few, rather large, scattered, brown, lepidote scales, about equally narrowed to the somewhat acuminate apex and to the acute base, distinctly 3-nerved, the lateral nerves extending to the apex; petioles about 3 cm long, somewhat furfuraceous on their margins, or quite glabrous. Panicles terminal, pyramidal, brown-furfuraceous, about 7 cm long, the branches few, spreading, the flowers white and pink, rather congested, the subtending bracts deciduous, oblong, 6 to 8 mm long. Calyx urceolate, brown-lepidote, about 6.5 mm long and wide, 5-toothed, the teeth

broad, blunt or acute. Petals 5, orbicular-reniform, about 5 mm in diameter.

LUZON, Camarines Province, Mount Isarog, *Phil. Pl. 1569 Ramos* (type), November 23, 1913, in the mossy forest near the summit, altitude about 1,900 meters: Sorsogon Province, Mounts Pacdal and Kililibong, *Bur. Sci. 23371, 23568, 23501 Ramos*, August, 1915.

A species allied to *Astronia viridifolia* Elm., *A. megalantha* Merr., and *A. negrosensis* Merr., but distinguished from all by its coriaceous leaves being finely and densely verruculose on both surfaces. The flowers are unusually large for the genus, as in *A. megalantha* Merr.

BECCARIANTHUS Cogniaux

BECCARIANTHUS ICKISII Merr. var. PUBERULA var. nov.

A typo differt ramulis et petiolis perspicue setosis, foliis subtus minutissime et densissime puberulis.

LUZON, Tayabas Province, Infanta-Siniloan trail, *Bur. Sci. 29230 Ramos & Edaño*, June 12, 1917, on forested ridges.

This form differs from the type in its prominently setose branchlets and petioles, the soft setae attaining a length of 12 mm; on the petioles they are confined to the lower inner one-third to one-half, and are distinctly longer than those in the var. *setosa* Merr. The diagnosis of the latter variety, Philip. Journ. Sci., 10 (1915) Bot. 278 should be corrected by the addition of the figure 9 before the word "nerviis." The present variety, like the type, has 7-nerved leaves but differs from it and the variety *setosa* in its leaves being uniformly and densely puberulent on the lower surface, the indumentum being pale-brownish in color.

MEDINILLA Gaudichaud

MEDINILLA APAYAOENSIS sp. nov.

Frutex glaber, circiter 2 m altus, ramis ramulisque teretibus vel subteretibus; foliis oppositis, coriaceis, oblongo-ellipticis, usque ad 18 cm longis, utrinque subaequaliter angustatis, apice obtusis vel latissime et breviter acuminatis, basi acutis vel decurrento-acuminatis, 5-plinerviis, nervis transversis reticulisque subobsoletis; petiolo 1 ad 2 cm longo; paniculis terminalibus, pedunculatis, usque ad 25 cm longis, multifloris, ramis primariis verticillatis, inferioribus circiter 10 cm longis; bracteis membranaceis, lanceolatis ad oblanceolatis, 1 ad 1.4 cm longis; floribus 5-meris, petalis circiter 9 mm longis.

An erect glabrous shrub about 2 m high, the branches and branchlets terete or subterete, pale, the latter about 4 mm in diameter, the nodes sparingly setose. Leaves opposite, coriaceous, rather pale when dry, slightly shining, of about the same color on both surfaces, oblong-elliptic, 13 to 18 cm long, 6 to 8 cm wide, subequally narrowed to the blunt or very broadly blunt-acuminate apex and to the acute or decurrent-acuminate base, prominently 5-plinerved, in larger leaves sometimes 7-

plinerved, the inner pair of nerves more prominent than the outer ones and anastomosing with the midrib just below the apex, the transverse nerves and reticulations obsolete or nearly so; petioles stout, 1 to 2 cm long. Panicles terminal, pyramidal, peduncled, up to 25 cm long, the branches verticillate, the lower ones about 10 cm long, the bracts subtending the branches subpersistent, membranaceous, lanceolate to oblanceolate, 10 to 14 mm long. Flowers pale-purplish, 5-merous. Calyx cup-shaped, truncate, about 4 mm long. Petals about 9 mm long. Stamens 10, equal, the filaments and anthers each about 7 mm in length.

LUZON, Apayao Subprovince, Ngagan, *Bur. Sci. 28142 Fénix*, May 10, 1917, an epiphyte on large trees in damp forests.

The alliance of this species is with *Medinilla apoensis* C. B. Rob. (*M. confluentinervia* Elm.), of southeastern Mindanao, from which it is readily distinguished by its prominently petioled leaves, those of *M. apoensis* being sessile or subsessile.

MEDINILLA FENICIS sp. nov.

Arbor parva usque ad 8 m alta, ramis ramulisque teretibus, partibus junioribus et subtus foliis ad costa nervisque, et inflorescentiis plus minusve plumoso-tomentosis; foliis oppositis, coriaceis, oblongo-ellipticis, utrinque subaequaliter angustatis, basi acutis, 3-plinerviis, apice breviter obtuseque acuminatis, usque ad 8 cm longis; inflorescentiis terminalibus, paniculatis, laxis, usque ad 13 cm longis; bracteis membranaceis, oblongis ad obovatis, 8 ad 11 mm longis; floribus 4-meris, petalis circiter 8 mm longis.

A small tree attaining a height of about 8 m, the younger branchlets, lower surface of the leaves on the costa and nerves, and the inflorescences more or less plumose-tomentose with pale-brownish hairs, the indumentum sometimes dense, more or less deciduous, the older parts eventually becoming glabrous or nearly so. Branches and branchlets terete, pale, the former smooth, the latter 2 to 3 mm in diameter. Leaves coriaceous, oblong-elliptic, 6 to 8 cm long, 2.3 to 3 cm wide, pale-brownish, of about the same color on both surfaces, and slightly shining when dry, brittle, subequally narrowed to the acute, prominently 3-plinerved base and to the shortly and bluntly acuminate apex, the lateral nerves leaving the midrib in the lower 3 mm and extending to the apex, the transverse nerves and reticulations obsolete; petioles pubescent when young, eventually glabrous, 7 to 14 mm long. Panicles terminal, peduncled, up to 13 cm long, lax, the branches opposite. Bracts conspicuous, membranaceous, apparently pink, oblong to obovate, sparingly pubes-

cent to glabrous, obtuse, 8 to 11 mm long. Flowers pedicelled, in threes at the tip of each ultimate branchlet, 4-merous. Calyx cup-shaped, truncate, about 4 mm long. Petals dark-purple, about 8 mm long.

LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28426 Fénix*, May, 1917, on damp rocky slopes near the summit of the mountain, altitude not indicated.

A strongly marked species among those with pubescent vegetative parts, not very similar to any described form, but most closely allied to *Medinilla cordata* Merr. It is distinguised from *Medinilla cordata* by numerous characters, especially in its entirely differently shaped, prominently petioled leaves which are gradually narrowed to the acute base.

MEDINILLA LONGIDENS sp. nov.

Frutex circiter 1 m altus, perspicue plumoso-tomentosus; ramis ramulisque teretibus; foliis oppositis, valde inaequalibus, chartaceis, ovato-ellipticis ad oblongo-ovatis, minoribus usque ad 4 cm longis, majoribus usque ad 8 cm longis, acute acuminatis, basi angustatis, obtusis ad leviter cordatis, 5-plinerviis, petiolatis; inflorescentiis axillaribus, breviter pedunculatis, plerumque bifloris; bracteis conspicuis, lanceolatis, acuminatis, circiter 15 mm longis, utrinque pubescentibus; floribus 4-meris, brevissime pedicellatis, calycis lobis lanceolatis, acuminatis, 4 ad 5 mm longis.

An erect shrub about 1 m high, the branchlets, petioles, lower surface of the leaves, and inflorescences densely plumose-tomentose, the indumentum dirty brown or pale, the branches and branchlets terete, the former glabrous, pale, the latter about 2 mm in diameter. Leaves opposite, petioled, those of each pair very unequal in size, the larger ones 6 to 8 cm long and 2.5 to 3.5 cm wide, the smaller ones 3 to 4 cm long and 1.5 to 2 cm wide, chartaceous, pale-grayish when dry, acuminate or acute, base narrowed, obtuse to slightly cordate, 5-plinerved, the transverse nerves and reticulations obsolete, the upper surface glabrous; petioles of the larger leaves 8 to 12 mm long, of the smaller ones 2 to 4 mm in length. Inflorescences axillary, solitary, mostly 2-flowered, the peduncles 5 mm long or less, the flowers subtended by an involucre of pink, lanceolate, acuminate, pubescent bracts about 15 mm in length. Flowers 4-merous. Young fruit ovoid, 4-celled, pubescent, about 6 mm long, the persistent calyx-teeth lanceolate, pubescent, acuminate, 4 to 5 mm long.

LUZON, Apayao Subprovince, *Bur. Sci. 28422 Fénix*, May 23, 1917, in damp forests near the base of Mount Sulu, altitude about 800 meters.

A characteristic species strongly marked among the plumose-tomentose species by its very unequal leaves, its axillary mostly 2-flowered, conspi-

cuously bracteate inflorescences, and its 4-merous flowers with long calyx-teeth. It somewhat resembles *Medinilla microphylla* Merr. and *M. parva* Merr., but is not very closely allied to either.

MEDINILLA MACGREGORII sp. nov.

Frutex erectus gemmis exceptis glaber, ramis ramulisque teretibus; foliis oppositis, petiolatis, oblongo-ellipticis, coriaceis, utrinque acuminatis vel basi acutis, usque ad 7 cm longis, triplinerviis, in siccitate pallidis; inflorescentiis lateralibus, laxis, paucifloris, divaricato-ramosis, usque ad 8 cm longis, bracteis suborbicularibus, prominentibus; floribus 4-meris.

An erect, slender, shrub, quite glabrous except the young buds which are densely ferruginous-setose, the very youngest branchlets also sometimes setose. Branches and branchlets slender, light-gray, terete. Leaves opposite, oblong-elliptic, 5 to 7 cm long, 2.5 to 3 cm wide, about equally narrowed at both ends, apex blunt-acuminate, base acute or acuminate, pale and somewhat shining when dry, coriaceous, 3-plinerved, the two lateral nerves leaving the midrib about 5 mm above the base and reaching the apex, there anastomosing with the midrib, the lateral nerves and reticulations obsolete; petioles 5 to 7 mm long. Inflorescence lateral, from the axils of fallen leaves, mostly solitary, slender, up to 8 cm in length, the few branches divaricately spreading, each bearing few bracteate flowers at their apices. Bracts orbicular to reniform, apparently pink, concave, submembranaceous, 5 to 6 mm long, 6 to 7 mm wide, in pairs at the nodes, the bracteoles closely enveloping the flowers, similar to the bracts but smaller. Pedicels very short. Flowers apparently pink, 4-merous. Petals 4, 5 mm long. Stamens 8; anthers oblong, about 2 mm long. Young fruits cup-shaped, 3.5 mm in diameter, truncate.

LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19863 McGregor*. February 11, 1913, in the mossy forest.

A very characteristic species, distinguished by its comparatively small, pale, 3-plinerved leaves and its very lax, divaricately and slenderly branched, few-flowered, bracteate, lateral inflorescences. It is not at all closely allied to any of the known Philippine forms having opposite leaves, lateral inflorescences, and 4-merous flowers.

MEDINILLA MEMBRANACEA sp. nov.

Frutex erectus, glaber, circiter 1 m altus, ramis ramulisque teretibus; foliis ternatis, petiolatis, membranaceis, oblongis, usque ad 5 cm longis, nervis lateralibus obsoletis, basi acutis, apice acuminatis; inflorescentiis lateralibus, brevibus, subumbellatim 3-floris vel unifloris; floribus tenuiter pedicellatis, 5-meris; petalis circiter 8 mm longis.

An erect entirely glabrous shrub about 1 m high, the branches pale, terete, the branchlets very slender, 1 to 2 mm in diameter. Leaves ternate, membranaceous, olivaceous and somewhat shining when dry, oblong, 3 to 5 cm long, 1.2 to 1.8 cm wide, narrowed below to the acute base and above to the blunt-acuminate apex, the midrib distinct, the lateral nerves and reticulations entirely obsolete; petioles slender, 2 to 4 mm long. Inflorescences lateral, axillary, solitary, few, the peduncles about 8 mm long, with up to three subumbellately arranged flowers, or the flowers sometimes solitary, the slender pedicels about as long as the peduncles. Flowers white, 5-merous. Calyx cup-shaped, truncate, about 4 mm long. Petals about 8 mm long.

LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28361 Fénix*, May 22, 1917, in damp forests on rocky slopes, altitude apparently about 800 meters.

A most characteristic species not at all closely allied to any other described Philippine forms, although in texture of its leaves and in the nerves and reticulations being entirely obsolete it resembles *Medinilla benguetensis* Elm.

MEDINILLA PANAYENSIS sp. nov.

Frutex glaber, 2 m altus; ramulis 4-angulatis, nodis barbatis; foliis elliptico-ovatis, oppositis, petiolatis, chartaceis, 5-plinerviis, basi acutis, apice acuminatis, usque ad 20 cm longis; inflorescentiis terminalibus, amplis, pedunculatis, paniculatis, folia subaequantibus, bracteis bracteolisque nullis; floribus 5-meris.

An erect shrub about 2 m high, glabrous except the densely setose-barbate nodes. Branches obscurely 4-angled, stout, the branchlets rather sharply 4-angled and sometimes very narrowly 4-winged. Leaves chartaceous, elliptic-ovate, opposite, about equally narrowed at both ends, the base acute, the apex acuminate, 15 to 20 cm long, 8 to 10 cm wide, somewhat brown when dry, slightly shining, the lower surface very slightly paler than the upper, with two pairs of prominent nerves, the outer pair leaving the midrib 1 to 1.5 cm above the base, evanescent at the middle or above, the inner pair leaving the midrib at from 2.5 to 3 cm above the base, anastomosing with the midrib at the apex, the transverse veinlets slender, distant, obsolete or nearly so on the lower surface, evident on the upper surface; petioles stout, 2 to 4 cm long. Inflorescence terminal, peduncled, ample, paniculate, about as long as the leaves, the rachis and branches, when fresh, waxy-white, the bracts and bracteoles wanting, or small and very early deciduous. Flowers 5-merous, pink. Calyx cup-shaped, about 5 mm long and wide, truncate. Petals 5, 10 mm long. Stamens 10, 5 slightly shorter than the others; filaments 4 to 5 mm long; anthers narrowly lanceolate,

acuminate, 5 and 6.5 mm long, dorsal appendages short, the anterior one very small or nearly obsolete.

PANAY, Iloilo Province, Ulian River, *Bur. Sci. 18253 Robinson*, January 11, 1913, altitude 250 meters.

This is more closely allied to *Medinilla apoensis* C. B. Rob. (*M. confluentinervia* Elm.), than to any other Philippine form, but is very different from that species, being distinguished by its rather long-petioled leaves which have fewer nerves, and by its distinctly 4-angled, not terete branchlets.

MEDINILLA PARVIBRACTEA sp. nov.

Species *M. magnificae* affinis, differt floribus minoribus, bracteis multo minoribus, 1.5 ad 2.5 cm longis, nodis vix setosis.

An erect shrub or small tree 4 to 7 m high, quite glabrous. Branches stout, terete or obscurely 4-angled, the ultimate branchlets with 4, thick, narrow wings. Leaves opposite elliptic-ovate to somewhat obovate-elliptic, sessile, 20 to 30 cm long, 10 to 16 cm wide, coriaceous, somewhat shining, the apex shortly and abruptly acuminate, the base somewhat narrowed, prominently 11-plinerved, the interior two pairs of nerves reaching the apex, the others evanescent, the transverse nervules very slender, nearly obsolete on the lower surface. Panicles solitary, terminal and lateral, peduncled, 14 to 25 cm long, the peduncles 7 to 9 cm long, the branches in whorls of 4, spreading, the lower ones 5 to 9 cm long, each whorl subtended by 4, membranaceous, broadly ovate to oblong-obovate, obtuse to subacute, apparently colored bracts 1.5 to 2.5 cm long. Flowers pink, 5-merous. Calyx urceolate, about 4 mm long, the limb somewhat spreading, truncate, the mouth 4 mm in diameter. Petals 5, obliquely obovate, 8 mm long. Stamens 10, subequal; filaments about 5 mm long; anthers as long as the filaments, somewhat curved, acuminate, lanceolate, the dorsal spur very short, the anterior two stout, curved, about 1 mm long. Ovary 5-celled.

BABUYAN ISLANDS, Camiguin, summit of the volcano, *Bur. Sci. 4151 Fénix* (type), July 7, 1907, the inflorescence terminal. BATAN ISLANDS, Batan, Mount Iraya, *Bur. Sci. 3820 Fénix*, June 12, 1907, in forests near the summit of the mountain, inflorescence lateral. LUZON, Cagayan Province, Caua Volcano, *R. N. Clark*, August, 1908, in forests, altitude 1000 m, inflorescence terminal.

This is manifestly very closely allied to *Medinilla magnifica* Lindl., from which it differs in its smaller flowers and very much smaller bracts. The specimens with terminal inflorescence manifestly represent the same species as the one with a lateral inflorescence. In this genus it is not uncommon to find both lateral and terminal inflorescences on the same specimen, a character that is not always shown by ordinary herbarium material.

MEDINILLA PELTATA sp. nov.

Frutex glaber, ramulis 4-angulatis, crasse et anguste 4-alatis; foliis oppositis, petiolatis, ovatis ad oblongo-ovatis, coriaceis,

acuminatis, base late rotundatis, distincte peltatis, 3- vel 5-nerviis; cymis usque ad 6 cm longis, caulifloris vel e ramis vetustioribus; floribus 5-meris, minutissime bracteolatis, staminibus aequalibus.

A glabrous shrub, the branches prominently 4-angled, each angle with a thick but narrow wing, pale-brownish, about 5 mm in diameter. Leaves opposite, distinctly peltate, coriaceous, ovate to oblong-ovate 10 to 13 cm long, 4.5 to 8 cm wide, the apex sharply acuminate, base broadly rounded, 3- or 5-nerved, the inner pair of nerves prominent, reaching the apex, the outer pair, when present, submarginal, evanescent below the apex; lateral nerves nearly obsolete on the lower surface, rather distinct on the upper; petioles 2 to 3.5 cm long attached to the leaf about 5 mm from its margin. Cymes up to 6 cm long, few-flowered, from the trunk or the larger branches, the minute bracteoles linear, 2 mm long or less, deciduous. Calyx cup-shaped or somewhat urceolate, about 8 mm long, the tube extending about 2.5 mm above the ovary, truncate, undulate, 5-glandular. Petals 5, obliquely oblong-obovate, about 1.4 cm long and 7 mm wide. Stamens 10, equal; filaments 8 mm long; anthers lanceolate, acuminate, curved, 8 to 9 mm long, the dorsal appendage curved, blunt, about 1.7 mm long the two anterior appendages stout, yellow, curved, about 1.5 in diameter.

BILIRAN, Mount Suiro, *Bur. Sci. 18953 McGregor*, June 10, 1914, in the mossy forest, altitude 600 to 900 meters, the flowers transparent, light phlox-purple.

A most characteristic species, at once distinguishable in the genus by its peltate leaves. According to Cogniaux's arrangement of the species it falls in the group with *Medinilla laurifolia* Blume but is not closely allied to that species or to any other form known to me.

MEDINILLA POLISENSIS sp. nov.

Species *M. clementis* affinis, differt foliis multo minoribus, usque ad 13 cm longis, basi rotundatis, 5-plinerviis, antheris majoribus.

A stout vine climbing in trees, glabrous except the setose nodes. Branches terete, somewhat reddish-brown, the younger branchlets obscurely 4-angled to prominently 4-winged, the internodes 2 to 5 cm long. Leaves opposite, coriaceous, oblong to oblong-elliptic, 8 to 13 cm long, 2 to 4 cm wide, base rounded or obtuse, apex acuminate, the upper surface pale when dry, shining, the lower somewhat brownish, the base prominently 5-plinerved, sometimes with an additional fainter basal pair, the inner pair leaving the midrib at from 2 to 3 cm above the base and reaching the apex where they anastomose with the midrib,

the transverse nerves obsolete or barely visible on the upper surface; petioles about 1 cm long. Inflorescence terminal, red, long-peduncled, paniculate, the peduncle about 14 cm long, the panicle as long as the peduncle, the branches in distant whorls, the lower ones about 4 cm long. Flowers pink or pale violet, 5-merous, the bracts and bracteoles, if any, small and very early deciduous. Calyx about 6 mm long, cup-shaped, truncate. Petals 5, about 10 mm long, obliquely obovate. Stamens 10, subequal; filaments 6 to 7 mm long; anthers narrowly lanceolate, acuminate, 8 mm long, the dorsal appendage reduced to a very minute, 0.2 mm long tubercle, the anterior ones produced about 1.5 mm below the insertion of the filament, somewhat curved, oblong.

LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19870 McGregor*, February 10, 1913.

Manifestly a close ally of *Medinilla clementis* Merr., differing in the characters indicated in the diagnosis.

MEDINILLA STENOBOTRYS sp. nov.

Frutex epiphyticus, glaber, circiter 2 m altus, ramulis incrassatis, 4-angulatis, 4-alatis, circiter 1 cm diametro; foliis coriaceis, oppositis, sessilis, usque ad 30 cm longis, elliptico-ovatis, acuminatis, perspicue 9-plinerviis; inflorescentiis terminalibus, trinis, angustis, multifloris, 25 ad 30 cm longis et 4 cm latis, rhachibus valde incrassatis, alatis; floribus numerosissimis, 4-meris, secus rhachin fasciculatis vel cymosis, cymis fasciculatis.

A stout, glabrous, epiphytic shrub about 2 m high, the ultimate branches 4-angled, 4-winged, about 1 cm in diameter. Leaves opposite, coriaceous, rather pale when dry, somewhat shining, sessile, elliptic-ovate, 24 to 30 cm long, 17 to 22 cm wide, apex acuminate, the acumen rather stout, about 1 cm long, the base somewhat narrowed and more or less clasping the stem, prominently 9-plinerved, lateral nerves leaving the midrib in the lower 9 to 11 cm, the inner two pairs reaching the tip of the leaf, the transverse nerves and reticulations lax, obscure. Inflorescences terminal, each branchlet terminated by three stout, narrow, racemose panicles 25 to 30 cm in length and about 4 cm in diameter, the rachis stout, about 1 cm in diameter when dry, the membranaceous wings 2 to 4 mm in width, the peduncles 8 to 10 cm long. Flowers 4-merous, dark-pink, very numerous, fascicled or cymose and the cymes fascicled at the nodes of the rachis, often crowded. Calyx cup-shaped, truncate, about 4 mm long. Petals 4, oblong-obovate, somewhat oblique, 7 to 8 mm long. Stamens 8, equal, the filaments and anthers each about

4 mm long; pedicels about 5 mm long; bracts membranaceous, oblong-ovate, rather deciduous, up to 9 mm in length.

LUZON, Apayao Subprovince, Mount Sulu, *Bur. Sci. 28355 Fénix*, May 23, 1917, on trees along streams in damp forests, altitude about 800 meters, known to the Ibanags as *lalannug*.

Among all the Philippine species with very large, opposite, sessile or nearly sessile leaves this is the most strongly characterized one. It is readily recognized by its narrow, rather dense, raceme-like inflorescences which are borne in threes at the tips of the branchlets, a type of inflorescence otherwise not known among the numerous Philippine representatives of the genus.

MEDINILLA TAYABENSIS sp. nov.

Frutex epiphyticus, glaber, ramis ramulisque teretibus vel ramulis plus minusve 4-angulatis; foliis oppositis, petiolatis, crasse coriaceis, ellipticis ad late elliptico-ovatis, in siccitate brunneo-olivaceis, usque ad 17 cm longis, basi late acutis ad rotundatis, perspicue 7- vel 9-plinerviis, apice abrupte et brevissime rostrato-acuminatis; paniculis terminalibus, 20 ad 30 cm longis, crasse pedunculatis, pyramidatis, ramis ramulisque verticillatis, incrassatis et cum pedunculo rhachibusque tenuiter 4-alatis, bracteis lineari-lanceolatis, inconspicuis, 2 ad 3 mm longis; floribus 4-meris, petalis circiter 8 mm longis.

An epiphytic glabrous shrub, the branches and branchlets terete, or the latter inconspicuously 4-angled and 4 to 5 mm in diameter, the nodes more or less setose. Leaves opposite, thickly coriaceous, brownish-olivaceous, of about the same color on both surfaces, and somewhat shining when dry, elliptic to broadly elliptic-ovate, 12 to 17 cm long, 7 to 12 cm wide, base broadly acute to rounded, conspicuously 7- or 9-plinerved, the inner pair of nerves anastomosing with the midrib near the apex, the transverse reticulations lax, obsolete on the lower surface, obscure on the upper surface, the apex very shortly and abruptly rostrate-acuminate, the acumen blunt, 2 to 3 mm long and as wide as long; petioles stout, 1 cm long or less. Panicles terminal, peduncled, pyramidal, 20 to 30 cm long, the peduncle and rachis stout, when dry and more or less flattened nearly 1 cm wide, narrowly 4-winged, the wings 1 to 2 mm wide, membranaceous, the branches and branchlets stout and similarly winged; branches verticillate, the lower ones up to 10 cm in length, the secondary and tertiary branchlets also verticillate. Flowers numerous, 4-merous, pink, their pedicels about 5 mm long, the bracts inconspicuous, linear-lanceolate, 2 to 3 mm long. Calyx cup-shaped, truncate, about 4 mm long. Petals 4, about 8 mm long. Stamens 8, equal, the filaments and anthers each about

4 mm long. Fruits ovoid-globose, truncate, 5 to 6 mm in diameter.

LUZON, Tayabas Province, Mount Binuang, *Bur. Sci. 28605* (type), *28637 Ramos & Edaño*, May 7, 1917, on trees in the mossy forest.

The alliance of this species is apparently with *Medinilla negrosensis* Merr., from which is distinguished by its differently shaped, much thicker leaves which are abruptly and very shortly blunt-acuminate; and the stout peduncles, branches, and branchlets of its inflorescences which are narrowly 4-winged.

MEDINILLA TRIANAE sp. nov.

Frutex scandens, glaber, ramis ramulisque teretibus; foliis verticillatis, petiolatis, oblongo-ellipticis ad oblongo-obovatis, chartaceis vel subcoriaceis, nitidis, 5 ad 9 cm longis, apice breviter abrupteque acuminatis, basi angustatis, acutis vel acuminatis, tenuiter trinerviis; inflorescentiis e ramis defoliatis, brevibus, paucifloris, 2 ad 3 cm longis; fructibus 4-locellatis.

A scandent glabrous shrub, the branches and branchlets terete, the latter slender, nodes not bearded. Leaves verticillate, 3 to 5 at each node, oblong-elliptic to oblong-obovate, 5 to 9 cm long, 2 to 4.5 cm wide, shining and of about the same color on both surfaces when dry, slightly pustulate, the apex very abruptly and shortly acuminate or obtuse, the base narrowed and acute or somewhat decurrent-acuminate, slenderly 3-nerved, the lateral pair nearly or quite reaching the apex, transverse nerves and reticulations obsolete or very obscure; petioles 1 to 2.5 cm long. Inflorescences from the nodes on the branches below the leaves, short, few-flowered, 2 to 3 cm long. Flowers not seen. Fruit red, 4-celled, fleshy when fresh, urceolate, about 1 cm long, the ovoid portion crowned by the short, cylindric, truncate calyx-rim.

LUZON, Laguna Province, Dahican, *Phil. Pl. 1131 Ramos*, September, 1912, in forests along the river.

A species manifestly allied to *Medinilla subumbellata* Merr., which it resembles in vegetative characters, although differing in size and other details of the leaves.

MEDINILLA VULCANICA sp. nov.

Frutex erectus, glaber, ramis ramulisque teretibus; foliis oppositis, ellipticis ad ovato-ellipticis, subcoriaceis, usque ad 20 cm longis, brevissime acuminatis, basi rotundatis vel subacutis, sessilis, 7-plinerviis, reticulis obsoletis; paniculis terminalibus, multifloris, pedunculatis, ramis ramulisque verticillatis, folia aequantibus vel longioribus; floribus parvis, 4-meris.

An erect, entirely glabrous shrub or small tree (5 m high, fide Ramos). Branches and branchlets terete, the nodes not at

all setose. Leaves subsessile, elliptic to elliptic-ovate, subcoriaceous, somewhat shining when dry, the lower surface a little paler then the upper one, 9 to 20 cm long, 5.5 to 11 cm wide, the base rounded or subacute, the apex abruptly and very shortly acuminate; petiole none or very short and stout; base 7- rarely 9-plinerved, the inner two pairs reaching to the apex or nearly so, prominent, the reticulations obsolete. Panicles terminal, peduncled, the peduncles about 8 cm long, the panicles ovoid, up to 15 cm long, the branches and branchlets whorled, the lower branches up to 7 cm in length, the upper ones gradually shorter. Flowers pink, 4-merous, their pedicels 4 to 7 mm long, the bracteoles linear or filiform, short, deciduous. Calyx somewhat urceolate-campanulate, about 3.5 mm long, truncate. Petals 4, obliquely obovate, 7 mm long, about 4 mm wide. Stamens 8, equal or subequal; filaments 4 mm long; anthers as long as the filaments, lanceolate, acuminate, the dorsal spur less than 0.5 mm long, the anterior basal appendages short, blunt, rather broad.

CAMIGUIN DE MINDANAO, in forests on slopes of the volcano, *Phil. Pl. 1164 Ramos*, March 24, 1912.

A species closely allied to *Medinilla myriantha* Merr. *M. confusa* Merr. and allied forms, distinguished by its 7-plinerved leaves, small flowers, etc.

MEDINILLA TENUIPES nom. nov.

Medinilla gracilipes Merr. in Philip. Journ. Sci. 8 (1913) Bot. 249, non *M. gracilipes* Merr. op. cit. 236.

Inadvertently the same specific name was ued for two entirely distinct and unrelated species, both of which were published in the same paper. The second species published under the name *Medinilla gracilipes* is here renamed *Medinilla tenuipes* Merr.

MELASTOMA Linnaeus

MELASTOMA CULIONENSE sp. nov.

Frutex erectus, ramulis et foliis et calycis adpresse strigosis; foliis chartaceis, oblongo-lanceolatis, acuminatis, basi acutis, 5-nerviis, usque ad 9 cm longis, supra adpresse strigosis, subtus leviter strigoso-setulosis; floribus 5-meris, bracteatis, calycibus haud dense strigosis, tubo quam lobis paulo brevioribus, denticulis alternantibus ad setis reductis; antherarum majorum connectivum basi longe productum.

An erect shrub, the branches brown, terete or nearly so, glabrous, the younger branchlets appressed-strigose, the scales not dense and 1 mm long or less. Leaves chartaceous, oblong-lanceolate, 6 to 9 cm long, 1.5 to 2.3 cm wide, apex rather slenderly and sharply acuminate, base acute, the upper surface olivaceous when dry, appressed strigose with scattered, very

short scales, the lower surface paler, sparingly strigose-setulose on the midrib, nerves, and reticulations; nerves 5 from the base, distinct; petioles appressed hirsute-strigose, 5 to 10 mm long. Flowers solitary in the uppermost axils or in few flowered terminal cymes, each young flower subtended by a pair of oblong-lanceolate, strigose, acuminate bracts about 8 mm long, these bracts somewhat penicillate at the apex, deciduous, more or less enclosing the young buds. Calyx-tube 6 to 7 mm long, sparingly appressed-strigose with entire, sharp scales less than 1 mm in length, these scales scattered, not at all obscuring or covering the surface of the tube, the lobes 5, lanceolate, acuminate, about 8 mm long, appressed strigose, apex slightly penicillate, the alternating teeth reduced to mere bristles 2 mm long or less. Petals 5, oblong-obovate, about 2 cm long, 11 mm wide, apex obtuse or rounded and a little penicillate. Stamens 10, very unequal; the five longer ones with anthers about 7 mm long, lanceolate, acuminate, the connective produced about 12 mm below the anther, with small anterior appendages, the filaments proper 8 to 10 mm long; the five shorter stamens with anthers equaling those of the longer stamens, but the connectives produced but about 1 mm, the filaments about 8 mm long.

CULION, Halsey Harbor, *Bur. Sci. 21647 Escritor*, August 25, 1913.

The alliance of this species is manifestly with *Melastoma malabathricum* Linn. as interpreted by Cogniaux, but is so distinct that it cannot properly be referred to that species nor to any of the forms that have been reduced to it. It is strongly characterized by its slightly strigose calyx, the strigose scales scattered, not at all imbricate or overlapping and not nearly covering the surface of the calyx tube; its lobes a little longer than the tube; and the alternating teeth reduced to mere bristles 2 mm long or less which are not at all penicillate or hairy in any respect.

MELASTOMA SUBALBIDUM sp. nov.

Frutex erectus 1 ad 1.5 m altus, ramulis et foliis et calycis brevissime adpresse strigosis; foliis oblongis vel oblongo-lanceolatis, usque ad 5 cm longis, 5-nerviis, acute acuminatis, subtus pallidis; floribus 5- vel 6-meris, parvis, albidis vel subalbidis, petalis circiter 1.3 cm longis, staminibus subaequalibus, connectivo basi brevissime producto.

An erect shrub 1 to 1.5 m high, the branches terete, pale grayish-brown, glabrous, the branchlets very slender, densely strigose with short, strictly appressed lanceolate, acuminate, usually purplish scales hardly exceeding 1 mm in length. Leaves oblong to oblong-lanceolate, chartaceous, 3 to 5 cm long, 1 to 1.5 cm wide, the upper surface green when dry, sparingly appressed-strigose with scattered, appressed, short, sharp scales,

the lower surface much paler than the upper, glabrous except for the sparingly appressed-strigose nerves and reticulations, the apex rather sharply acuminate, the base obtuse or rounded, 5-nerved; petioles densely strigose, 5 mm long or less. Flowers white or very pale-pink, in few-flowered, terminal, ebracteate cymes, the cymes 2 to 3 cm long, the flowers rarely or never exceeding 9 in each. Calyx ovoid, including the lobes about 1 cm long, outside very densely strigose with simple, closely appressed, narrowly ovate, acuminate, usually purplish scales, the tube ovoid, about 6 mm long and 5.5 mm in diameter, the lobes 5 or 6, lanceolate, about 4 mm long, densely strigose, alternating with very small, 1.5 mm long scales scarcely larger than those on the tube. Petals 5 or 6, obovate, nearly equilateral, about 1.3 cm long, 9 mm wide, apex broadly rounded-truncate, margins more or less ciliate. Stamens 10 or 12, slightly unequal, the longer filaments 7 mm long, the shorter 6 mm, the anthers oblong, obtuse, straight, the longer ones 3 mm long, connectives produced 1 mm, the shorter ones 2.5 mm long, the connectives produced 0.5 mm, the anterior appendages in both curved, 0.5 mm long. Ovary 5- or 6-celled, the apex subconical, densely hirsute.

LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19835 McGregor*, February, 1913.

A very characteristic species, belonging in the third group, as outlined by Cogniaux, with *Melastoma denticulatum* Bl., *M. mariannum* Naud., *M. sylvaticum* Bl., and *M. francavillanum* Cogn. Striking characters are its small leaves, somewhat glaucous beneath and glabrous on the lower surface except for the nerves and reticulations, its small, nearly white flowers, and its short anthers which are slightly unequal in length, the connectives produced but 0.5 to 1 mm.

OTANTHERA Blume

OTANTHERA PARVIFLORA sp. nov.

Frutex circiter 1 m altus omnibus partibus longe penicillato-setosis; foliis chartaceis, oblongis, acuminatis, usque ad 9 cm longis, basi acutis, 5-nerviis; paniculis terminalibus, paucifloris; floribus 5-meris, circiter 1 cm diametro.

A shrub about 1 m high, all parts supplied with spreading, slender, setose hairs 3 to 4 mm in length, those on the leaves usually pale, those on the branchlets and inflorescence purplish. Branches gray, terete, slender, setose-penicillate. Leaves oblong, chartaceous, green and of about the same color on both surfaces when dry, 5 to 9 cm long, 1.5 to 3 cm wide, apex acuminate, base acute, rarely somewhat rounded, 5-nerved, the outer pair of nerves more slender than the inner ones, both surfaces setose-penicillate; petioles 8 to 10 mm long. Panicles terminal,

few-flowered, the bracts green, sessile, reniform-ovate, acuminate, 3 to 4 mm long, the pedicels about 3 mm long. Flowers 5-merous, pink. Calyx cup-shaped, 4 to 5 mm long, densely covered with spreading purplish hairs 3 to 4 mm in length, the lobes linear-lanceolate, 3 mm long, setose-penicillate. Petals (from nearly mature buds) orbicular-ovate, 4 to 5 mm long, margins ciliate, apex penicillate. Stamens 10, equal; anthers oblong, 2 mm long. Fruit globose, about 5 mm in diameter.

MINDANAO, Zamboanga District, Sax River Mountains back of San Ramon, *Merrill 8082*, November 28, 1911, in damp shaded ravines on talus slopes, and on ridges, altitude 800 to 1100 m, rare.

A species well characterized by its small flowers, in this readily distinguishable from the other species of the genus.

OTANTHERA MACGREGORII sp. nov.

Frutex 1.5 ad 2 m altus, erectus, ramis ramulisque gracilis, teretibus vel obscure tetragonis; foliis oblongis vel oblongo-ovatis, acuminatis, basi 5-nerviis, supra adpresse strigosis, subtus ad nervis nervulisque setoso-strigosis; floribus 5-meris calycis setis simplicibus, curvato-adpressis, strigosis, lobis lanceolatis, 5 mm longis; petalis roseis, 6 mm longis.

An erect shrub, 1.5 to 2 m high, the branches and branchlets terete or obscurely 4-angled, very slender, uniformly and rather densely appressed-strigose, brownish when dry. Leaves oblong to oblong-ovate, chartaceous, 5 to 8 cm long, 1.5 to 2.5 cm wide, the apex acuminate, base acute, 5-nerved, the upper surface uniformly appressed-strigose, the setae 1 to 2 mm long, the lower surface setose-strigose with somewhat curved setae on the nerves and reticulations; petioles about 5 mm long, strigose. Panicles terminal and axillary, few-flowered, usually about 2 cm long, sessile or peduncled, the bracts narrowly ovate, acuminate, setose, about 3 mm long. Flowers 5-merous. Calyx-tube globose, about 5 mm in diameter, covered with curved-appressed simple setae about 1 mm in length, the lobes lanceolate, acuminate, as long as the tube, ciliate-setose. Petals pink, broadly obovate, 6 mm long, 7-nerved, reticulate, equilateral, the apex broad, subtruncate, the margins slightly ciliate-setose. Stamens 10, equal; filaments about 2.5 mm long; anthers as long as the filaments, narrowly oblong, obtuse, the connective not at all produced, the anterior basal appendages two, very short. Style 5 mm long.

LUZON, Nueva Vizcaya Province, Imugan, *Bur. Sci. 14408 McGregor*, April 26, 1912.

This species is manifestly allied to *Otanthera celebica* Blume, differing however in many characters, but especially in its calyx-lobes being more than twice as long as in Blume's species and equaling the tube in length.

MEMECYLON Linnaeus

MEMECYLON OBSCURINERVE sp. nov. § *Eumemecylon.*

Frutex glaber, ramis ramulisque teretibus; foliis oblongis ad oblongo-ovatis, usque ad 6 cm longis, coriaceis, brevissime petiolatis, crasse coriaceis, acuminatis, basi acutis ad obtusis, supra olivaceis, subtus flavo-viridis, nervis lateralibus et transversabus subobsoletis; inflorescentiis axillaribus, fasciculatis, circiter 2.5 cm longis, floribus numerosis, albidis, calycis circiter 2 mm diametro.

A glabrous shrub about 3 m high, the branches and branchlets brownish, terete, the latter smooth, about 1.5 mm in diameter. Leaves thickly coriaceous, oblong to oblong-ovate, 4 to 6 cm long, 1.5 to 3 cm wide, apex acuminate, base acute to obtuse, the upper surface olivaceous when dry, the lower yellowish-green; lateral longitudinal nerves very obscure, scarcely visible, becoming obsolete in the upper part of the leaf, the transverse ones no more distinct than the longitudinal ones, about 6 on each side of the midrib, reticulations obsolete; petioles stout, 1 to 2 mm long. Inflorescences mostly in the axils of fallen leaves, fascicled, peduncled, about 1.5 cm long, the peduncles 4 to 7 mm long, mostly reduced to simple umbels, the larger ones with short secondary branches. Flowers numerous, white, their pedicels about 2 mm long, the calyces about 2 mm in diameter.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26401 Ramos & Edaño*, August 20, 1916, on forested slopes, altitude about 400 meters.

A species well characterized by its obscurely nerved leaves, the transverse and lateral nerves present but scarcely more than visible, the reticulations obsolete. Its alliance is apparently with *Memecylon lanceolatum* Blanco, but it is entirely different from Blanco's species.

MEMECYLON OLIGOPHLEBIUM sp. nov. § *Eumemecylon.*

Frutex glaber circiter 3 m altus, ramis ramulisque tenuibus, teretibus, vel ramulis ultimis obscurissime sulcatis; foliis ellipticis, coriaceis, usque ad 5 cm longis, abrupte et breviter acuminatis, basi acutis vel decurrento-acuminatis, obscure triplinervis, nervis lateralibus patulis, utrinque circiter 6, supra impressis, subtus magis indistinctis, anastomosantibus, nervis secundariis reticulisque obsoletis; infructescentiis 1 ad 2 cm longis, pedunculatis vel e basi ramosis; fructibus globosis, circiter 5 mm diametro.

A glabrous erect shrub about 3 m high, the branches and branchlets slender, terete, dark reddish-brown, smooth, or the ultimate branchlets sometimes very obscurely sulcate. Leaves elliptic, thickly coriaceous, 3.5 to 5 cm long, 2 to 3 cm wide,

apex abruptly and shortly acuminate, base acute or decurrent-acuminate, the upper surface strongly shining, brownish-olivaceous, the lower somewhat paler, the midrib very prominent on the lower surface; lateral nerves about 6 on each side of the midrib, spreading, straight, anastomosing with the arcuate longitudinal pair of nerves at from 3 to 5 mm from the margin, the base obscurely triplinerved, all nerves impressed on the upper surface, less distinct on the lower surface than on the upper, the secondary ones and reticulations obsolete; petioles 4 to 5 mm long. Infructescences axillary, solitary, 1 to 2 cm long, peduncled or branched from the base, the fruits somewhat crowded at the ends of the primary branches, globose or depressed-globose, about 5 mm in diameter, subsessile or very shortly pedicelled.

MINDANAO, Surigao Province, Managas, Carrascal, *For. Bur. 26475 Mallonga*, December 13, 1916, on dry slopes, altitude about 50 meters.

This species is well characterized by its small, elliptic, thickly coriaceous, abruptly and shartly acuminate leaves, with the slender nerves impressed on the upper surface, the lateral spreading ones straight, and the longitudinal connecting nerves arcuate and distant from the margin of the leaf.

MEMECYLON PACHYPHYLLUM sp. nov. § *Eumemecylon*.

Frutex 3 ad 4 m altus, glaber, ramis ramulisque teretibus; foliis crassissime coriaceis, sessilis, ovatis ad elliptico-ovatis, vel oblongo-ovatis, usque ad 12 cm longis, basi late rotundatis vel obscurissime cordatis, apice obtusis ad rotundatis, nervis transversalibus circiter 10, tenuibus, lateralibus obscuris, leviter arcuatis; paniculis axillaribus vel e axillis defoliatis, usque ad 3 cm longis, ramis brevibus, patulis; fructibus ovoideis, circiter 6 mm longis.

A glabrous shrub 3 to 4 m high, the branches and branchlets rather stout, terete, the latter smooth, reddish-brown, shining. Leaves very thickly coriaceous, stiff, sessile, ovate, elliptic-ovate, or oblong-ovate, brownish-olivaceous, shining, of the same color on both surfaces when dry, 7 to 12 cm long, 3.5 to 6.5 cm wide, base very broadly rounded or sometimes obscurely cordate, apex broadly rounded to obtuse, margins somewhat revolute; transverse nerves about 10 on each side of the midrib, slender, not prominent, rather more distinct than are the longitudinal lateral nerves which are slightly arched between the ends of the transverse ones. Inflorescences axillary and from the axils of fallen leaves, solitary or sometimes two in an axil, up to 3 cm long, the branches spreading. Fruits ovoid, about 6 mm long.

LUZON, Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26475* (type), *26464 Ramos & Edaño*, August, 1914, altitude 250 to 350 meters: Tayabas

Province, Mount Binuang, near Infanta, *Bur. Sci. 9383 Robinson*, August, 1909, altitude 875 meters, *Bur. Sci. 28666 Ramos & Edaño*, May 27, 1917.

A species characterized by its very thick, round to broadly obtuse, sessile leaves. It is perhaps as closely allied to *Memecylon diversifolium* Presl, as any other species, but cannot be referred to Presl's species, the type of which was from Malacca, not from the Philippines, and which proves to be a synonym of *Memecylon coeruleum* Jack.

MEMECYLON SYMPLOCIFORME sp. nov. § *Eumemecylon.*

Frutex glaber, circiter 5 m altus, ramis ramulisque teretibus, tenuibus; foliis coriaceis, oblongo-ellipticis ad oblongo-lanceolatis, usque ad 8 cm longis, petiolatis, utrinque subaequaliter angustatis acuminatisque, nervis reticulisque obsoletis; infructescentiis axillaribus, brevibus, fructibus ellipsoideis vel oblongo-ovoideis, circiter 1 cm longis, basi distincte inaequilateralibus.

A glabrous shrub about 5 m high, the branches and branchlets slender, terete, the ultimate branchlets less than 1 mm in diameter, brownish or pale. Leaves greenish-olivaceous, slightly shining, the midrib prominent, the lateral nerves and reticulations obsolete on both surfaces, coriaceous, oblong-elliptic to oblong-lanceolate, 5 to 8 cm long, 1.8 to 3 cm wide, subequally narrowed to the acuminate base and to the rather slenderly acuminate apex; petioles 2 to 3 mm long. Infructescences axillary and from the axils of fallen leaves, the peduncles about 5 mm long, simple or with two short branches at the apex, each bearing one or two fruits. Fruits ellipsoid or oblong-ovoid, about 1 cm long, brown and smooth when dry, the base distinctly inequilateral, rounded on one side, acute on the other.

LUZON, Tayabas Province, Pacific coast, vicinity of Mount Dingalan, *Bur. Sci. 26598 Ramos & Edaño*, August 27, 1916, on slopes, altitude about 195 meters, the fruits described as white when fresh, the local (Bulugo) name *ambatiki.*

A species well characterized by its acuminate, nerveless leaves and its somewhat elongated fruits which are distinctly inequilateral at the base. In aspect it rather strongly resembles some species of *Symplocos.* Its alliance is apparently with *Memecylon lanceolatum* Blanco and *M. gitingense* Elm., from both of which it is at once distinguished by its fruit characters.

MEMECYLON TAYABENSE sp. nov.

Arbor circiter 10 m alta, glabra, ramis 4-angulatis, ramulis prominente 4-alatis; foliis oblongis, coriaceis, nitidis, in siccitate utrinque pallide viridis, usque ad 22 cm longis, acuminatis, basi late rotundatis cordatisque, brevissime petiolatis, nervis supra impressis, subtus valde prominentibus, transversalibus utrinque 12 ad 15, rectis, cum lateralibus valde prominentis leviter arcuatis anastomosantibus; inflorescentiis terminalibus, e basi ramosis, circiter 7 cm longis, paniculatis, ramis oppositis, ramulis sub-

verticillatis, ramulis 4-angulatis; floribus breviter pedicellatis, in ramulis ultimis subcapitato confertis.

A tree about 10 m high, entirely glabrous. Branches dark-brown, distinctly 4-angled, the branchlets paler, 4-angled and narrowly 4-winged, the wings about 1 mm wide. Leaves opposite, coriaceous, pale-greenish when dry, of the same color and shining on both surfaces, 18 to 22 cm long, 5.5 to 7 cm wide, somewhat narrowed upward to the acuminate apex, the base broadly rounded, cordate, subsessile, the petioles at most 1.5 mm long; nerves impressed on the upper surface, very prominent on the lower, the transverse ones straight or nearly so, 12 to 15 on each side of the midrib, anastomosing at from 5 to 8 mm from the margin with the slightly arched, equally prominent, longitudinal nerves which extend from the base nearly or quite to the apex; primary reticulations lax, faint, the others obsolete. Panicles terminal, about 7 cm long, paniculate, branched from the base, the branches opposite, the branchlets verticillate, the lower primary branches up to 6 cm in length, all distinctly 4-angled, dark-brown when dry. Flowers numerous, shortly pedicelled, densely crowded in globose, subcapitate, partial inflorescences about 1 cm in diameter at the tips of the ultimate branchlets.

LUZON, Tayabas Province, Atimonan, *For. Bur. 24932 Bawan*, December 12, 1915, on forested ridges, altitude about 200 meters, locally known as ***guis-guis***.

A characteristic species in the alliance with *Memecylon terminaliflorum* Elm. and *M. pteropus* Merr., differing from the latter in its sessile, much shorter inflorescences and larger leaves, and from the former especially in its globose, subcapitate partial inflorescences, its differently shaped, thicker leaves, its prominently 4-winged branchlets, and its sessile inflorescences.

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SOME RECENTLY COLLECTED PHILIPPINE FUNGI

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The partial results of a study of some of the more recent collections of Philippine fungi are presented in the present paper. Some apparently new forms are described, and a considerable number of previously described species are listed.

Within the past two or three years many specimens of fungi have been sent to European specialists for study, but on account of the unsettled conditions due to the present war no reports on these specimens have been received. However, none of the material of which duplicates have been sent to specialists has been discussed by me in the present paper. None of the *Basidiomycetes* are reported in this contribution although a number of forms, especially in the *Uredinaceae*, have been determined and several apparently undescribed species have been located. No attempt has been made to determine the recently collected *Polyporaceae*. The Philippine forms of this group are now in a most chaotic condition and the study of them could best be made by some specialist who has comprehensive collections from all parts of the world with access to types and authentically named specimens.

It is of interest to note that in all of our recently collected material forms referable to the genera *Meliola* and *Asterina* are especially numerous. This may in part be explained by the fact that the representatives of these genera are for the most part inconspicuous forms which may have been overlooked by previous collectors. The genus *Meliola* has by far more known species in the Philippines than any other genus of the *Ascomycetes*, while *Asterina* is second in this respect.

The host relations of our species of *Meliola* and *Asterina* are in great need of careful field and laboratory study. Many of the species of the former genus appear to be restricted to a single host, or at most to representatives of the same genus or family; but a few species have been reported on hosts belonging in more than one family of higher plants.

CENANGIACEAE

TRYBLIDIELLA Saccardo

TRYBLIDIELLA MINDANAENSIS P. Henn. in Philip. Journ. Sci. 3 (1913) Bot. 53.

ALABAT, back of Sangirin, *Merrill 10529*, December 25, 1916. On dead stems of *Premna*.

PHACIDIACEAE

RHYTISMA Fries

RHYTISMA LAGERSTROEMIAE Rabh. in Hedw. 17 (1878) 31.

Rhytisma pongamiae Berk. & Br. ex Cooke in Grev. 6 (1877) 110.

LUZON, Rizal Province, *Bur. Sci. 26753 Ramos*, October-November, 1916; Antipolo, *Bur. Sci. 17382 Ramos*, January, 1914: Bataan Province, Mount Mariveles, *Bur. Sci. 16763 Graff*, April, 1912. On the leaves of *Lagerstroemia speciosa*.

PERISPORIACEAE

MELIOLA Fries

MELIOLA AFFINIS Syd. in Leafl. Philip. Bot. 6 (1913) 192.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25699 Yates*, December, 1916. On leaves of *Memecylon* sp.

MELIOLA DESMODI Karst. et Roum. in Revue Myc. (1890) 77.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21785 Ramos*, September, 1913. On the leaves of *Desmodium latifolium*.

MELIOLA HAMATA Syd. in Ann. Myc. 12 (1914) 548.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25659 Yates*, December, 1916. On the leaves of *Buchanania arborea*.

MELIOLA HEWITTIAE Rehm in Philip. Journ. Sci. 8 (1913) Bot. 253.

LUZON, Cavite Province, Talisay Ridge, *Merrill 10632*, January 21, 1917: Bulacan Province, Angat, *Bur. Sci. 21847 Ramos*, September, 1913. On the leaves of *Hewittia sublobata*.

MELIOLA ARTOCARPIAE sp. nov.

Mycelio epiphyllo, plagulas atras, orbiculares, 3-5 mm diam., ex hyphis sparsis brunneis septatis 8-10 μ crassis composito, ramis irregularibus; hyphopodiis capitatis numerosis, alternantibus vel irregularibus, cellula superiore globosa, 15 μ lata, vel elongata et 24 μ longa, 18 μ lata, cellula inferiore 10-12 μ longa; hyphopodiis mucronatis, paucis, irregularibus, ampulliformibus, 15-20 μ longis; setis mycelicis numerosis, 350-500 μ longis, erectis, ad basim abrupte geniculatis et 10 μ crassis, inferne atris et opacis, superne obscure brunneis, acutis vel obtusis; perithecciis numerosis, 100-200 μ diam., globosis, atris, opacis, tuberculatis; ascis 2-4-sporis, 70-80 x 20-35 μ; sporidiis brun-

neis, 4-septatis, cylindraceis, ad septa constrictis, utrinque late rotundatis 50-55 μ longis, 20-25 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24692 Ramos*, February 7, 1916. On leaves of *Artocarpus* sp.

The specimens are parasitized by *Spegazzinia meliolae* A. Zimm.

MELIOLA BARRINGTONIAE sp. nov.

Epiphylla, maculas orbiculares 2-4 mm diam., saepe confluentes, atras; mycelio ex hyphis paucis flexuosis radiantibus irregulariter ramosis brunneis septatis 10 μ latis composito; hyphopodiis capitatis numerosis, plerumque oppositis, vel alternantibus, cellula superiore globosa 12-14 μ lata; cellula inferiore 5 μ longa; hyphopodiis mucronatis paucis, ampulliformibus, usque ad 20 μ longis, 12 μ latis; setis mycelicis numerosis, atris, opacis, validis, 200-300 μ longis, 12-18 μ latis, erectis, rectis vel leviter curvatis, acutis; perithecciis globosis, atris, opacis, tuberculatis, 140-200 μ diam.; ascis ellipsoideis, 4-sporis, evanescentibus, 50-60 μ longis, 18-22 μ latis; sporidiis cylindraceis, utrinque late rotundatis, 4-septatis, ad septa constrictis, brunneis, 40-45 μ longis, 14-18 μ latis.

LUZON, Cavite Province, *Bur. Sci. 22600 Ramos & Deroy*, April 18, 1916. On leaves of *Barringtonia luzonensis*.

The rather short, thick setae are characteristic.

MELIOLA CADIGENSIS sp. nov.

Hypophylla, maculas atras 5-8 mm diam., dein confluentes et plus minusve effusa formans; mycelio ex hyphis septatis 6-7 μ diam. obscure brunneis composito, ramis oppositis vel irregularibus; hyphopodiis capitatis numerosis, oppositis vel irregularibus, cellula superiore rotundata, 12-14 μ longa, 10 μ lata, inferiore 5 μ longa; hyphopodiis mucronatis numerosis, ampulliformibus, usque ad 20 μ longis; setis mycelicis numerosissimis, erectis, ad basim geniculatis, 450-550 μ longis, 10 μ crassis, atris, opacis; perithecciis numerosis in quaque macula, globosis, tuberculatis, 130-170 μ diam.; ascis non visis; sporidiis cylindraceis, utrinque late rotundatis, 4-septatis, ad septa constrictis, obscure brunneis, 35-40 μ longis, 14-16 μ latis.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25822 Yates*, December 16, 1916. On leaves of *Glycosmis cochinchinensis*.

MELIOLA CATUBIGENSIS sp. nov.

Amphigena, plerumque epiphylla, maculas atras, orbiculares, 5-10 mm diam., vel confluentes et folium superficium plus minusve continua obtecta, mycelio ex hyphis brunneis septatis ramosis 8-10 μ crassis composito; hyphopodiis capitatis numerosis, alternantibus, cellula superiore globosa vel ovata, 12 μ diam., inferiore

5 μ longa; hyphopodiis mucronatis paucis, plerumque oppositis, ampulliformibus, usque ad 15 μ longis; setis mycelicis 250 μ longis, 8-10 μ latis, erectis, rectis vel leviter curvatis, inferne atris, opacis, apicem versus septatis, obscure brunneis, obtusis; perithecciis paucis, minutis, 60-80 μ diam., globosis, obscure brunneis, subopacis, tuberculatis; ascis non visis; sporidiis 4-septatis, ad septa constrictis, cylindraceis, utrinque late rotundatis, brunneis, 30-34 μ longis, 12-15 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24624 Ramos*, February 17, 1916. On leaves of *Loranthus*.

Meliola loranthi Gaill. the only other species of *Meliola* recorded as occurring on *Loranthus* is described as having the mycelial setae forked. The perithecia in *M. loranthi* are described as 150-200 μ in diameter, and the spores 62-68 x 24-26 μ.

MELIOLA CONNARIAE sp. nov.

Amphigena, maculas orbiculares vel irregulares 1-2 cm latas atras velutinas formans, saepe confluentes et magnam partem folium occupantes; mycelio ex hyphis septatis brunneis radiantibus ramosis 8-10 μ latis composito; hyphopodiis capitatis alternantibus vel irregularibus, cellula superiore oblonga 15-20 μ longa, 18-22 μ lata, cellula basali 8-10 μ longa; hyphopodiis mucronatis paucis, alternantibus vel oppositis, ampulliformibus, usque ad 25-30 μ longis; setis mycelicis numerosis, saepe prope basim perithecciis, erectis, rectis vel leviter curvatis, 600-700 μ longis, 12-15 μ latis, atris, opacis, simplicibus, acutis vel obtusis; perithecciis numerosis, globosis, atris, tuberculatis, 150-170 μ diam.; ascis oblongo-ovatis, 60-70 μ longis, 35-40 μ latis, 2-4-sporis; sporidiis oblongis, utrinque late rotundatis, 4-septatis, ad septa constrictis, obscure brunneis, 50-55 μ longis, 20-25 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25622 Yates*, December 20, 1916. On leaves of *Connarus*.

The *Meliola* is associated with a species of *Helminthosporium*. Some of the spores are only 10 to 12 μ in diameter.

MELIOLA DIOSPYRIAE sp. nov.

Amphigena, plerumque epiphylla, maculas atras, velutinas, orbiculares vel irregulares formans; mycelio abundante, ex hyphis obscure brunneis 8 μ crassis composito; hyphis matrici adpresso; ramis oppositis vel irregularibus; hyphopodiis capitatis numerosis, oppositis, cellula superiore subglobosa, 12-15 μ lata, cellula inferiore 4-5 μ longa; hyphopodiis mucronatis paucis, ampulliformibus, usque ad 20 μ longis; setis mycelicis numerosis, erectis, rectis, vel leviter curvatis, 500-650 μ longis, 10 μ latis,

atris, opacis, simplicibus, acutis; peritheciis paucis in quaque macula, globosis, atris, tuberculatis, 80-120 μ diam., ascis non visis; sporidiis cylindraceis, utrinque late rotundatis, 4-septatis, ad septa leviter constrictis, brunneis, 45-55 μ longis, 20-22 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25711 Yates*, December 8, 1916. On leaves of *Diospyros discolor*.

MELIOLA ELAEOCARPEAE sp. nov.

Amphigena, plagulas atras, pelliculosas, orbiculares, 1-6 mm diam., saepe confluentes, mycelio ex hyphis ad basim peritheciis centrifugis ramosis oppositis brunneis septatis 6-10 μ latis composito; hyphopodiis capitatis numerosis, oppositis, cellula superiore ovoidea, 10-12 μ diam., cellula basali 5-6 μ longa; hyphopodiis mucronatis paucis, irregularibus vel oppositis, ampulliformibus, 15-18 μ longis, 6-8 μ latis; setis mycelicis erectis, rectis vel ad basim geniculatis, simplicibus, 300 μ longis, 10-12 μ latis, atris, opacis, apicem versus brunneis, acutis vel obtusis; peritheciis paucis in quaque macula, subglobosis, obscure brunneis, tuberculatis, 100-120 μ diam., ascis evanescentibus; sporidiis 4-septatis, brunneis, ad septa constrictis, utrinque late rotundatis, 55 μ longis, 22 μ latis.

LUZON, Benguet Subprovince, *Bur. Sci. 25175 Yates*, May 3, 1916. On leaves of *Elaeocarpus*.

The very numerous, opposite, capitate hyphopodia together with the comparatively short thick setae are characteristic.

MELIOLA IXORIAE sp. nov.

Amphigena, maculas atro-griseas, orbiculares vel irregulares, 5-15 mm diam., saepe confluentes; mycelio abundante, ex hyphis septatis flexuosis brunneis 5-8 μ crassis composito; ramis oppositis vel irregularibus; hyphopodiis capitatis numerosis, alternantibus vel unilateralibus, cellula superiore lobata vel rotundata 12-16 μ longa, 10-15 μ lata; inferiore 5-12 μ longa, 6 μ lata; hyphopodiis mucronatis paucis, oppositis vel irregularibus, ampulliformibus, 12-14 μ longis; setis mycelicis 600-750 μ longis, 8-10 μ latis, erectis, rectis vel leviter curvatis, saepe ad basim geniculatis, inferne opacis, atris, simplicibus, acutis; setis peritheciis circiter 8 ad basim quaque perithecium; peritheciis globosis, atris, opacis, tuberculatis, 100-125 μ diam.; ascis 2-4-sporis 55-65 μ longis, 20-26 μ latis; sporidiis oblongis, utrinque rotundatis, 4-septatis, ad septa non constrictis, saepe leviter curvatis, 40 μ longis, 14 μ latis.

LUZON, Manila and vicinity, *Bur. Sci. 25841 Yates*, February, 1917. On leaves of *Ixora philippinensis*.

MELIOLA LEUCOSYKEAE sp. nov.

Epiphylla, plagulas atras, orbiculares, 4-8 mm diam., mycelio sparso, ramis oppositis vel irregularibus, ex hyphis brunneis septatis 7-8 μ latis composito; hyphopodiis capitatis numerosis, alternantibus, cellula superiore subglobosa, 10 μ longa, 12-14 μ lata; cellula inferiore 5 μ longa; hyphopodiis mucronatis paucis, ampulliformibus, 10-15 x 4-7 μ; setis mycelicis numerosis, 300 μ longis, ad basim ad 8 μ latis, erectis, rectis vel leviter curvatis; inferne atris, opacis, apicem versus dilutiore brunneis, obtusis, peritheciis globosis, 230-260 μ diam., tuberculatis; ascis oblongis, 60-70 x 25-30 μ, 6-8-sporis; sporidiis 3-septatis, ad septa non constrictis, utrinque late rotundatis, fuscis, 35-40 μ longis, 14-16 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24621 Ramos*, February 17, 1916. On leaves of *Leucosyke capitellata*.

The 3-septate spores is the most characteristic feature of this species; no other species of *Meliola* with 3-septate spores has been reported on any of the *Urticaceae*.

MELIOLA LITSEAE sp. nov.

Mycelio amphigeno, plerumque hypophyllo, maculas atras, orbiculares 2-6 mm diam., saepe confluentes, mycelio ex hyphis paucis ramosis flexuosis irregularibus brunneis septatis 6-8 μ latis composito; hyphopodiis capitatis numerosis, alternantibus vel irregularibus, cellula superiore subglobosa, 15-18 μ diam.; cellula inferiore 6-8 μ longa; hyphopodiis mucronatis paucis, irregularibus, ampulliformibus, usque ad 20 μ longis; setis peritheciis et mycelicis circiter 800 μ longis, 12 μ latis, numerosissimis, erectis, rectis vel leviter curvatis, atris, opacis, simplicibus, acutis, vel ad apicem bi-tridentatis, iterum in ramulos duos divisis et ramulis bis ad apicem breviter bi-tridentatis; peritheciis numerosis, globosis, atris, opacis, tuberculatis, 170-200 μ diam., in sicco collapsis; ascis ovatis, 2-4-sporis, 60-65 μ longis, 38-40 μ latis; sporidiis oblongo-ovatis vel cylindraceis, utrinque late rotundatis, 4-septatis, ad septa constrictis, brunneis, 50-55 μ longis, 18-28 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24677 Ramos*, March 1, 1916. On leaves of *Litsea*.

This *Meliola* is distinguished by the long, forked setae, which appear to arise both from the mycelium and from the base of the perithecium.

MELIOLA LIVISTONIAE sp. nov.

Hypophylla, plagulas aterrimas, velutinas, orbiculares, 3-5 cm diam.; mycelio laxo, ex hyphis irregulariter ramosis obscure brunneis septatis 6-7 μ crassis ex peritheciis radiantibus com-

posito; hyphopodiis capitatis paucis, alternantibus vel irregularibus, numquam oppositis, cellula superiore irregulariter lobata, circiter 15-25 μ diam., cellula inferiore saepe curvata 20-25 μ longa; hyphopodiis mucronatis paucis, ampulliformibus, usque ad 20 μ longis; setis mycelicis numerosissimis, 300-350 μ longis, 8-9 μ latis, erectis, rectis vel leviter curvatis, opacis, acutis vel 2-3-denticulatis, dentibus 5-6 μ longis; peritheciis globosis, opacis, atris, tuberculatis, 175-250 μ diam.; ascis evanescentibus; sporidiis oblongis, 4-septatis, ad septa leviter constrictis, brunneis, utrinque late rotundatis, 50-55 x 12-22 μ.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25632 Yates*, December 19, 1916. On leaves of *Livistona*.

Meliola livistoniae is distinguished by the forked setae and the irregularly lobed capitate hyphopodia. There is great variation in the shape of the spores of this species; some of the spores are cylindric and slender, 12 μ diam., others are 20-22 μ diam.

MELIOLA MACARANGAE sp. nov.

Mycelio epiphyllo, plagulas orbiculares, atras, 2-5 mm diam., ex hyphis brunneis ramosis 7 μ crassis composito; hyphopodiis capitatis numerosis, plerumque oppositis, cellula superiore subglobosa, 8-10 μ diam.; cellula inferiore 4 μ longa; hyphopodiis mucronatis numerosis, ampulliformibus, usque ad 15 μ longis; setis mycelicis erectis, rectis, 170-220 μ longis, 10 μ latis, septatis, acutis vel apicem versus dilutioribus et obtusis; peritheciis globosis, subopacis, obscure brunneis, 120-150 μ diam., ostiolatis, tuberculatis; ascis oblongo-ovatis, 50 x 20 μ, 2-4-sporis; sporidiis 4-septatis, ad septa constrictis, oblongo-cylindraceis, utrinque late rotundatis 34-36 μ longis, 10-15 μ latis, fuscis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25621 Yates*, December 20, 1916. On leaves of *Macaranga tanarius*.

The setae are especially numerous in the vicinity of the perithecia. The ostiole is formed by a plate of thin-walled cells. This *Meliola* is associated with a species of *Helminthosporium*.

MELIOLA MAPANIAE sp. nov.

Amphigena, maculas atras, orbiculares, 1-5 mm diam., saepe confluentes; mycelio ex hyphis brunneis septatis e peritheciis radiantis 8-12 μ crassis composito; ramis oppositis; hyphopodiis capitatis numerosis, alternantibus, cellula superiore globosa vel subglobosa, 15-17 μ diam., cellula inferiore 10-14 μ longa; hyphopodiis mucronatis numerosis, plerumque alternantibus, ampulliformibus, usque ad 20-30 μ longis; setis mycelicis numerosis, erectis, rectis, atris, opacis, 500-800 μ longis, 15 μ crassis, simplicibus, acutis; ascis non visis; sporidiis oblongis, 4-septatis, ad

septa constrictis, brunneis, utrinque late rotundatis, 52-56 μ longis, 22-26 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24640 Ramos*, February 20, 1916. On leaves of *Mapania*.

MELIOLA SAMARENSIS sp. nov.

Plagulas atras, velutinas, confluentes et superficiem petioliorum obtecta, mycelio denso, ex hyphis obscure brunneis septatis 7-8 μ latis composito, ramis irregularibus; hyphopodiis capitatis paucis, alternantibus vel irregularibus, cellula superiore globosa, 15 μ diam., vel elongata et 10-15 x 15-20 μ; cellula inferiore, 4-5 μ longa; hyphopodiis mucronatis paucis; setis mycelicis numerosissimis, validis, 300 μ longis, 16 μ latis, erectis, leviter curvatis, opacis, atris, apice simplicibus, acutis; peritheciis numerosis, 150-250 μ diam., atris, opacis, tuberculatis, eostiolatis; ascis evanescentibus, 60-70 x 35-40 μ, 2-4-sporis; sporidiis 4-septatis, brunneis, oblongis, ad septa leviter constrictis, utrinque late rotundatis, 45-48 μ longis, 18-20 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24919 Ramos*, March 12, 1916. On the petioles of an unknown host.

Meliola samarensis seems to be most closely related to *M. aliena* from which it differs by the larger perithecia and more slender spores. The very numerous, short, thick setae completely obscure the mycelium and the perithecia, covering them with a tough plush-like growth.

MELIOLA SAUROPICOLA sp. nov.

Epiphylla, rariter caulicola, maculas dispersas, atras, orbiculares, 2-4 mm diam., saepe confluentes; mycelio ex hyphis ad basim perithecii centrifugis rectis septatis ramosis 6-8 μ latis composito; hyphopodiis capitatis numerosis, alternantibus vel irregularibus, bicellularibus, cellula superiore 15-20 μ longa, 10-12 μ lata, inferiore 8-10 μ longa; hyphopodiis mucronatis numerosis, alternantibus vel irregularibus, ampulliformibus, usque ad 20 μ longis; setis mycelicis erectis, rectis vel leviter curvatis, 500-650 μ longis, 12-15 μ latis, inferne opacis, atris, apicem versus obscure brunneis, obtusis, simplicibus; peritheciis rotundatis, applanatis, 110-160 μ diam., contextu ex cellulis plus minus radiantibus 6-8 μ diam. composito, in sicco collapsis; ascis evanescentibus, circiter 2-4-sporis; sporidiis cylindraceis, utrinque rotundatis, 4-septatis, ad septa leviter constrictis, fuscis, 42-45 μ longis, 15-17 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24705 Ramos*, February 15, 1916. On leaves of *Sauropus*.

The capitate hyphopodia are mostly alternate and are often 50 μ apart. The ostiole is formed by a plate of thin-walled cells.

MELIOLA TAYABENSIS sp. nov.

Hypophylla, maculas atras, orbiculares 1-2 cm diam., saepe confluentes et irregulares, dein plus minusve totum superficiem folium obtecta; mycelio ex hyphis obscure brunneis rectis septatis irregulariter ramosis 6 μ latis composito; hyphopodiis capitatis numerosis, alternantibus, cellula superiore subglobosa, circiter 10 μ lata, inferiore 6-7 μ longa; hyphopodiis mucronatis irregularibus, ampulliformibus, usque ad 17-20 μ longis, setis mycelicis numerosis, 250-300 μ longis, 8-10 μ latis, erectis, rectis vel leviter curvatis, atris, opacis, apice simplicibus, acutis vel obtusis; peritheciis paucis, globosis, glabris, atris, opacis, 150-200 μ diam., in sicco collapsis; ascis evanescentibus; sporidiis 4-septatis, fuscis, cylindraceis, utrinque late rotundatis, ad septa leviter constrictis, 40-50 μ longis, 14-16 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25649 Yates*, December, 1916. On leaves of *Linociera*.

This species is distinguished from *Meliola linocierae* Syd. by its somewhat larger spores, shorter mucronate hyphopodia, and longer setae.

MELIOLA TERAMNIAE sp. nov.

Amphigena, maculas atras, suborbiculares, 2-4 mm diam.; mycelio ex hyphis brunneis anastomosantibus 4-5 μ crassis composito, ramis irregularibus; hyphopodiis capitatis numerosis, alternantibus vel oppositis, cellula superiore ovoidea vel subglobosa, 10-12 μ lata, inferiore 4-5 μ longa; hyphopodiis mucronatis paucis, ampulliformibus, usque ad 20 μ longis; setis mycelicis numerosissimis, erectis, rectis vel leviter curvatis, 400-850 μ longis, 10 μ latis, septatis, inferne subopacis vel obscure brunneis, superne brunneis, plus minusve dilutioribus, simplicibus, acutis vel obtusis vel 2-3-furcatis, ramis 8 ad 15 μ longis; peritheciis paucis in quaque macula, globosis, tuberculatis, obscure brunneis, 90-120 μ diam.; ascis ovatis, 45-50 x 25 μ, 2-4-sporis; sporidiis elongatis, utrinque late rotundatis, 4-septatis, ad septa constrictis, fuscis, 40-44 μ longis, 15-17 μ latis.

LUZON, Kalinga Subprovince, *Bur. Sci. 25344 Yates*, March 27, 1916. On leaves of *Teramnus labialis*.

This *Meliola* appears to be quite close to *M. bicornis* Winter, differing from it mainly in mycelial characters. In the latter species the capitate hyphopodia are said to be opposite; in ours the perithecia and asci are somewhat smaller and the spores slightly larger than in *M. bicornis*. Comparison with material of *M. bicornis* might show this to be a variety of it rather than a distinct species.

PARODIELLA Spegazzini

PARODIELLA PERISPORIOIDES Speg. in Anal. Soc. Cient. Arg. 9 (1880) 178.

LUZON, Manila and vicinity, *Merrill 8393*, September-October, 1912. On leaves of *Desmodium triflorum*.

MICROTHYRIACEAE

ASTERINA Léveillé

ASTERINA CAPPARIDIS Syd. et Butl. in Ann. Myc. 9 (1911) 390.

LUZON, Manila and vicinity, *Bur. Sci. 25384 Yates*, August, 1916. On leaves of *Capparis micracantha*.

ASTERINA COLLICULOSA Speg. in Fung. Puigg. No. 347.

LUZON, Rizal Province, *Bur. Sci. 21902 Ramos*, August, 1913. On leaves of *Eugenia jambolana*.

ASTERINA ELMERI Syd. in Leafl. Philip. Bot. 4 (1911) 1156.

LUZON, Cavite Province, *Bur. Sci. 22610 Ramos & Deroy*, April-May, 1915. On the leaves of *Champereia manillana*.

ASTERINA SPONIAE Rac. Paras. Alg. Pilze Jav. 3 (1900) 34.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21845 Ramos*, September, 1913. ALABAT, back of Sangirin, *Merrill 10522*, December 21–30, 1916. On leaves of *Trema orientalis*.

ASTERINA ASTRONIAE sp. nov.

Epiphylla, plagulis suborbicularibus vel irregularibus, 4-8 mm diam., saepe confluentibus, atris, mycelio ex hyphis paucis brunneis septatis anastomosantibus irregulariter ramosis 3-4 μ latis composito; hyphopodiis unicellularibus, paucis, irregulariter distributis, ovoideis, elongatis integris vel lobatis, 5-6 μ longis, 4-6 μ latis, peritheciis numerosis in quaque macula, suborbicularibus, applanatis, 160-200 μ diam., irregulariter dehiscentibus, contextu radiatim, ex hypis obscure brunneis 2-4 μ diam. composito, ambitu vix fimbriatus; ascis subglobosis vel ovoideis, 45-55 x 28-35 μ, octosporis, paraphysatis; sporidiis conglobatis, oblongis, utrinque rotundatis, ad medio 1-septatis, constrictis, fuscis, 18-28 μ longis, 10-12 μ latis.

SAMAR, Catubig River, *Bur. Sci. 24695 Ramos*, March 21, 1916. On leaves of *Astronia* sp.

ASTERINA BREYNIAE sp. nov.

Epiphylla, maculas orbiculares vel irregulares, atras 1-3 mm diam., vel confluentes et plus minus totam folii superficiem obtecta; mycelio ex hyphis ramosis anastomosantibus obscure brunneis septatis 4-5 μ crassis composito; hyphopodiis paucis, alternantibus vel irregularibus, rotundatis, lobatis, vel angulatis, 10-15 μ longis, 7-8 μ latis; peritheciis numerosis, rotundatis,

obscure brunneis, subopacis, 40-50 μ diam., irregulariter dehiscentibus, contextu ex hyphis radiatis 3-4 μ latis composito, mox pseudo-parenchymatibus; ascis ovatis, 25-30 μ longis, 15 μ latis, octosporis, aparaphysatis; sporidiis elongatis, utrinque rotundatis, constrictis, fuscis, laevis, 12-15 μ longis, 4-5 μ latis, loculo superiore majore.

LUZON, Bontoc Subprovince, *Bur. Sci. 25257 Yates*, April 14, 1916. On leaves of *Breynia acuminata*.

The peculiar angular or lobed hyphopodia are characteristic of this species.

ASTERINA CIPADESSAE sp. nov.

Epiphylla, maculas atras, primo orbiculares, 2-4 mm diam., mox confluentes et plus minusve totam superficiem folia obtecta; mycelio ex hyphis brunneis ramosis anastomosantibus 3-4 μ crassis composito; hyphopodiis numerosis, plerumque oppositis vel etiam alternantibus, irregulariter 2-4-lobatis, 7-10 μ longis; peritheciis numerosis, 150-250 diam., obscure brunneis, subopacis vel opacis, rotundatis vel ellipsoideis, irregulariter dehiscentibus, contextu ex hyphis septatis radiatis 5-7 μ latis composito, margine vix fimbriatis; ascis ovatis, 35-45 μ longis, 22-27 μ latis, octosporis, paraphysatis; sporidiis oblongis, utrinque rotundatis, ad medio 1-septatis, constrictis, obscure brunneis, papillatis, 28-32 μ longis, 10-12 μ latis

LUZON, Kalinga Subprovince, *Bur. Sci. 25307 Yates*, March 30, 1916. On leaves of *Cipadessa*.

ASTERINA EUGENIAE sp. nov.

Hypophylla, maculas saepe marginales, usque 10 mm diam., orbiculares vel irregulares; mycelio ex hyphis paucis effusis laxis septatis obscure brunneis ramosis anastomosantibus 4-6 μ crassis composito; hyphopodiis paucis, alternantibus vel irregularibus, cylindraceis, rotundatis, 10-12 μ longis, 6 μ latis; peritheciis numerosis, applanatis, atris, opacis, 225-275 μ diam., centro perforatis, contextu ex hyphis radiantibus 3-5 μ latis composito; ascis oblongo-ovatis, paraphysatis, octosporis, 50-60 μ longis, 20-22 μ latis; sporidiis oblongis, utrinque rotundatis, 1-septatis, ad septa constrictis, hyalinis, 20 μ longis, 5 μ latis (immaturis), loculo superiore majore.

LUZON, Batangas Province, *Bur. Sci. 22678 Ramos & Deroy*, April 29, 1915. On leaves of *Eugenia*.

ASTERINA NYCTICALIAE sp. nov.

Maculis plerumque epiphyllis, orbicularibus vel irregularibus, atris, 3-5 mm diam., mycelio ex hyphis paucis septatis obscure brunneis composito, ramis plerumque oppositis, anastomosanti-

bus, 5-6 μ latis; hyphopodiis numerosis, plerumque alternantibus vel irregularibus, dichotomo-lobatis, 10-11 μ longis, 12-15 μ latis, 1-cellularibus; peritheciis numerosis, rotundatis, applanatis, minutis, 90-110 μ diam., obscure brunneis, sub-opacis, stellatim dehiscentibus; contextu radiatim, hyphis septatis 4-5 μ latis; ascis ovatis vel subglobosis, 26-28 x 18-20 μ, octosporis, paraphysatis; sporidiis oblongis, utrinque rotundatis, ad medio 1-septatis, constrictis, brunneis, laevis, 15-18 μ longis, 7-8 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25669 Yates*, Dec., 1916. On leaves of *Nycticalos cuspidatum*.

ASTERINA TAYABENSIS sp. nov.

Plagulis epiphyllis, atris, primo orbicularibus 3-4 mm diam., mox confluentibus, et magnam partem folii obtecta; mycelio abundante, ex hyphis brunneis septatis anastomosantibus ramosis irregularibus 4-6 μ latis composito; hyphopodiis paucis, dispersis, irregulariter distributis, breviter cylindraceis, rotundatis, 10-12 μ longis, 5-7 μ latis; peritheciis numerosis, globosis, 130-200 μ diam., tenuis, stellatim dehiscentibus, radiatim contextis ex hyphis 2-6 μ crassis; ascis subglobosis, octosporis, 25 x 30 μ; paraphysatis; sporidiis oblongis, utrinque rotundatis, ad medio 1-septatis, constrictis, echinatis, 22 μ longis, 10 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25635 Yates*, December 19, 1916. On the leaves of an unknown host.

ASTERINELLA Theissen

ASTERINELLA HYDNOCARPIAE sp. nov.

Epiphylla, maculas irregulares, 5-8 mm diam., vel confluentes et superficiem foliorum plus minusve obtecta; mycelio laxo ex hyphis radiantis 8 μ crassis brunneis composito, ramis irregularibus; hyphopodiis nullis; peritheciis numerosis in quaque macula, rotundatis et 300-400 μ diam., obscure brunneis, sub-opacis, contextu radiato, ex hyphis rectis brunneis 5 μ diam. composito, ambitu fimbriatis, poro centrali dehiscentibus; ascis globosis, 70 μ diam., octosporis, paraphysatis, sporidiis oblongo-ovoideis, ad medio 1-septatis, constrictis, fuscis, loculo supero parum latiore, 40-50 μ longis, 25-28 μ latis.

SAMAR, Catubig-River, *Bur. Sci. 24683 Ramos*, Feb.-Mar., 1916. On leaves of *Hydnocarpus falcatus*.

MORENOELLA Spegazzini

MORENOELLA MEMECYLI Syd. in Philip. Journ. Sci. 9 (1914) Bot. 183.

LUZON, Rizal Province, *Bur. Sci. 22701 Ramos*, June, 1915. On leaves of *Memecylon lanceolatum*.

MORENOELLA BEILSCHMIEDIAE sp. nov.

Hyphophylla, plagulas totum folium plus minusve occupans; mycelio parcissime evoluto, ex hyphis radiantibus ramosis anastomosantibus brunneis 3-5 μ crassis composito; peritheciis numerosis, primitus orbicularibus, tandem elongatis, 400-600 μ longis, 100-150 μ latis, rima latiuscula dehiscentibus, contextu ex hyphis radiantibus obscure brunneis 3-5 μ latis composito; ascis ovatis, 36-45 μ longis, 25-30 μ latis, octosporis; sporidiis oblongis, utrinque rotundatis, ad medio 1-septatis, vix constrictis, laevis, hyalino-fuscis, 25-30 μ longis, 6-7 μ latis, cellula superiore parum latiore quam inferiore.

SAMAR, Catubig River, *Bur. Sci. 24687 Ramos*, February 27, 1916. On the leaves of *Beilschmiedia nervosa*.

CAPNODIACEAE

AITHALODERMA Sydow

AITHALODERMA CLAVATISPORUM Syd. in Ann. Myc. 11 (1913) 388.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21798 Ramos*, September, 1913. On leaves of *Antidesma bunius*.

HYPOCREACEAE

NECTRIA Fries

NECTRIA STRIATULA sp. nov.

Stromatibus corticalis, sanguineis, suborbicularibus, erumpentibus, 0.5-1 mm diam., contextu aurantiaceis, parenchymaticis; peritheciis 3-12 in quaque stromata, subglobosis, 150-300 μ diam., ostiolis papillatis; ascis cylindraceis, 100 x 8 μ, octosporis, evanescentibus, aparaphysatis; sporis monostichis, ellipsoideis, utrinque obtusis, ad medio 1-septatis, non constrictis, olivaceis, membrana longitudinaliter striolata.

ALABAT, back of Sangirin, *Merrill 10519*, December 21–30, 1916. On a dead tree in forest.

The finely striated spores are characteristic of this species of *Nectria*.

POLYSTOMELLACEAE

INOCYCLUS Theissen et Sydow

INOCYCLUS PSYCHOTRIAE Syd. in Ann. Myc. 8 (1915) 211.

Hysterostomella psychotriae Syd. in Philip. Journ. Sci. 8 (1913) Bot. 275.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21804 Ramos*, September, 1913. On leaves of *Psychotria luzoniensis*.

ACTINODOTHIS Sydow

ACTINODOTHIS PIPERIS Syd. in Philip. Journ. Sci. 9 (1914) Bot. 175.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21843 Ramos*, September, 1913, on leaves of *Piper retrofractum:* Rizal Province, *Bur. Sci. 21928 Ramos*, August, 1913, on leaves of *Piper* sp.: Manila and vicinity, *Bur. Sci. 25380 Yates*, August, 1916, on leaves of *Piper* sp.

A very common fungus on *Piper* in the Philippines; in some localities almost all plants are affected. It does not appear to cause any particular harm to the plants.

PHYLLACHORACEAE

TRABUTIA Saccardo et Roumeguere

TRABUTIA BENGUETENSIS sp. nov.

Stromatibus hypophyllis, irregulariter dispersis, 1 mm diam., vel congregatis, 3-6 mm diam., rotundatis, atris; loculis applanatis, 450-500 μ diam., 60-70 μ altis; stroma opaca 30-35 μ crassa, interiore obscure brunneis, ex hyphis 3-4 μ crassis formato; ascis oblongo-ovatis 40 x 15 μ, octosporis, paraphysatis; sporidiis distichis, subglobosis, 1-cellularibus, hyalinis, 6 μ longis, 5 μ latis.

LUZON, Benguet Subprovince, *Bur. Sci. 25173 Yates*, May 3, 1916. On the leaves of *Ficus benguetensis.*

Trabutia benguetensis is distinguished from other species of *Trabutia* occurring on *Ficus* by its small spores.

CATACAUMA Theissen et Sydow

CATACAUMA ASPIDIUM (Berk.) Theiss. et Syd. in Ann. Myc. 13 (1915) 380.

Phyllachora ficium Niessl. var. *spinifera* Karst. et Har. in Rev. Myc. 12 (1890) 172.

SAMAR, Catubig River, *Bur. Sci. 24676 Ramos*, February-March, 1916. On leaves of *Ficus* sp.

CATACAUMA ASPIDIUM (Berk.) Theiss. et Sydow, forma **FICI-FULVAE** Theiss. et Syd. in Ann. Myc. 13 (1915) 381.

Phyllachora fici-fulvae Koord. in Verh. K. Akad. Wet. Amsterdam 2 (1907) 182.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25710 Yates*, December, 1916. On leaves of *Ficus* sp.

CATACAUMA LAGUNENSE Syd. in Ann. Myc. 13 (1915) 378.

Phyllachora lagunensis Syd. in Philip. Journ. Sci. 8 (1913) 278.

LUZON, Bontoc Subprovince, *Bur. Sci. 25262 Yates*, April-May, 1916. On leaves of *Ficus* sp.

CATACAUMA ELMERI Syd. in Ann. Myc. 13 (1915) 378.

Phyllachora elmeri Syd. in Leafl. Philip. Bot. 4 (1911), 1157.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25698 Yates*, December, 1916. On leaves of *Ficus* sp.

The spores of this specimen are somewhat immature. They are mostly 7–8 x 4–5 μ, while in the type they are 10–12 x 5.5–7 μ.

PHYLLACHORA Nitschke

PHYLLACHORA CANARI P. Henn. in Hedw. 47 (1908) 254.

LUZON, Rizal Province, *Bur. Sci. 21924 Ramos*, August, 1913: Bulacan Province, Angat, *Bur. Sci. 21791 Ramos*, September, 1913. On leaves of *Canarium villosum*.

PHYLLACHORA COICIS P. Henn. in Hedw. 34 (1895) 12.

LUZON, Ifugao Subprovince, *Bur. Sci. 25280 Yates*, April, 1916. On leaves of *Coix lachryma-jobi*.

PHYLLACHORA DALBERGIAE Niessl. in Hedw. 20 (1881) 99.

ALABAT, back of Sangirin, *Merrill 10554*, December 21–30, 1916. On leaves of *Dalbergia* sp.

PHYLLACHORA LUZONENSIS P. Henn. in Hedw. 47 (1908) 255.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25667, 25700 Yates*, December, 1916. On leaves of *Millettia* sp.

PHYLLACHORA PONGAMIAE P. Henn. in Hedw. 47 (1908) 255; Petch in Ann. Roy. Bot. Gard. Peradeniya 5 (1912) 291.

Rhytisma pongamiae Berk. et Br. Fungi of Ceylon No. 1128.
Cryptomyces pongamiae Sacc. in Syll. Fung. 8 (1889) 708.

ALABAT, back of Sangirin, *Merrill 10518*, December 21–30, 1916. On leaves of *Pongamia pinnata* (*P. glabra*).

PHYLLACHORA YAPENSIS (P. Henn.) Syd. in Philip. Journ. Sci. 8 (1913) Bot. 278.

Dothidella yapensis P. Henn. in Hedw. 41 (1902) 64.
Auerswaldia derridis P. Henn. in Hedw. 47 (1908) 255.
Phyllachora lagunae Rehm in Philip. Journ. Sci. 8 (1913) Bot. 396.

LUZON, Camarines Province, Mount Isarog, *Bur. Sci. 22123* Ramos, November-December, 1913: Ifugao Subprovince, *Bur. Sci. 25300 Yates*, April, 1916. On leaves of *Derris elliptica*.

SPHAERODOTHIS Shear

SPHAERODOTHIS ARENGAE (Racib.) Shear in Mycologia 1 (1909) 162.

Auerswaldia arengae Rac. in Parasit. Algen Pilze Jav. 3 (1900) 27.
Auerswaldia copelandi Syd. in Ann. Myc. 4 (1906) 343.

LUZON, Camarines Province, Mount Isarog, *Bur. Sci. 22127 Ramos*, November-December, 1916. On leaves of *Caryota cumingii*.

SPHAERIACEAE

MELANOPSAMMA Niessl.

MELANOPSAMMA MERRILLII sp. nov.

Peritheciis paucis, superficialibus, globosis, atris, carbonaceis, 200-500 μ diam., ostiolis papillatis; ascis cylindraceis, 120-130 μ longis, 8-10 latis, 4-sporis, paraphysatis, paraphysis filiformibus; sporidiis monostichis, ellipticis, ad medio 1-septatis et levissime constrictis, utrinque obtusis, hyalinis, 22-24 μ longis, 6-8 μ latis.

ALABAT, back of Sangirin, *Merrill 10554*, December 25, 1916. On trees in the virgin forest.

MYCOSPHAERELLACEAE

GUIGNARDIA Viala et Ravaz

GUIGNARDIA CREBERRIMA Syd. in Philip. Journ. Sci. 8 (1913) Bot. 482.

LUZON, Bulacan Province, Angat, *Bur. Sci. 21788 Ramos*, September, 1913, on living *Capparis horrida;* it is very common and abundant on this host.

GUIGNARDIA ARISTOLOCHIAE Syd. in Ann. Myc. 12 (1914) 555.

LUZON, Laguna Province, Calamba, *Merrill 9116:* Rizal Province, *Bur. Sci. 21959 Ramos*, August, 1913. On the living leaves of *Aristolochia tagala.*

MYCOSPHAERELLA Johanson

MYCOSPHAERELLA MERRILLII sp. nov.

Maculis definitis, orbicularibus, 1-2 cm diam., centro pallescente, margine luteus; peritheciis numerosis in quaque macula, atris, globosis, minutis, 70-100 μ diam., immersis, ostiolis epiphyllis, 5-8 μ latis, pertusis; contextu subopaco, fusco, ex cellulis 4-6 μ diam. composito; ascis cylindraceis, octosporis, 45-55 x 7-10 μ, aparaphysatis; sporidiis plerumque distichis, oblongis, utrinque rotundatis, ad medio 1-septatis, non constrictis, brunneis, 8-11 μ longis, 2.5-3.5 μ latis.

ALABAT, back of Sangirin, *Merrill 10542*, December 26, 1916. On the leaves of *Erythropalum.*

STIGMATEA Fries

STIGMATEA PHILIPPINENSIS sp. nov.

Maculis albo-griseis, orbicularibus vel elongatis, 5 mm diam. vel usque ad 3 cm longis et 1 cm latis; peritheciis immersis. ostiolis numerosis, epiphyllis, hemisphaericeis, 75-100 μ diam.; ostiolis orbicularibus; ascis elongatis, 26-30 μ longis, 10 μ latis, octosporis; sporidiis oblongo-ellipsoideis, ad medio 1-septatis, laevis, 12-13 μ longis, 3-4 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25662 Yates*, December 19, 1916. On leaves of *Homalium* sp.

PLEOSPORACEAE

MERRILLIOPELTIS P. Hennings

MERRILLIOPELTIS CALAMI P. Henn. in Hedw. 47 (1908) 262.

ALABAT, back of Sangirin, *Merrill 10530*, December 21–30, 1916. On dead stems of *Calamus*.

MERRILLIOPELTIS TAYABENSIS sp. nov.

Peritheciis solitariis vel plus minusve dense maculiformiter dispositis, subcortice positis dein epidermide elevata et pertusa; pseudostromata atra, effusa, saepe conjuncta, sublenticularis, 350-500 μ lata, 100-150 μ alta; ostiolo minutissimo, vix perspicuo, contextu opaco; ascis elongato-clavatis, apice valde incrassatis, stipitatis, 210-230 μ longis, 12-14 μ latis in perithecio fere horizontaliter dispositis; paraphysibus paucis; sporidiis plerumque distichis, fusiformibus, ad medio 1-septatis, non constrictis, hyalinis, utrinque longe et acutissime attenuatis, 90-100 μ longis 5-7 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25607 Yates*, December 19, 1916. On dead stems of *Calamus*.

This species is very near *Merrilliopeltis hoehnelii* Rehm, differing from it in the size of spores and asci and in the superficial appearance of the perithecia which are covered by the cortical layer of the host and are exposed only through cracks in the latter. It agrees with Rehm's species in the peculiar arrangement of the asci.

PLEOSPORA Rabenhorst

PLEOSPORA MISCANTHIAE sp. nov.

Culmicola, superficium culmis obtecta, velutinas, atras; mycelio ex hyphis obscure brunneis 6-10 μ crassis composito; peritheciis paucis, atris, laevis, 100-200 μ diam.; ascis clavatis, 140 μ longis, 26-32 μ crassis, octosporis, paraphysatis; paraphysis filiformibus, hyalinis; sporidiis muriformibus, oblongo-fusoideis, hyalinis, 16-20-septatis, 60-75 μ longis, 10-12 μ latis; conidiophoris erectis, 350-400 μ altis, 6-8 μ latis; conidiis brunneis, 9-11-septatis, 75-90 x 10-12 μ.

LUZON, Bontoc Subprovince, *Bur. Sci. 25231 Yates*, April 19, 1916. On the culms of *Miscanthus japonicus*.

This fungus presents a very characteristic appearance. The dead culms are covered by a dense velvety coating formed by the erect conidiophores. The perithecia are buried among and completely hidden by the conidiophores.

VALSACEAE

EUTYPA Tulasne

EUTYPA BAMBUSINA Penz. et Sacc. in Icones Fung. Java. (1904) 32.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25625 Yates*, December, 1916. On dead culms of bamboo. Also *Bur. Sci. 25599, 25640 Yates*, from the same locality.

This is one of the commonest of our Philippine fungi occurring everywhere upon dead culms of bamboo.

DIATRYPACEAE

DIATRYPE Fries

DIATRYPE CHLOROSARCA B. et Br.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25643 Yates*, December, 1916. On dead sticks lying on the ground in the forest.

XYLARIACEAE

HYPOXYLON Bulliard

HYPOXYLON EFFUSUM Nitsch. in Pyren. Germ. (1867–1870) 48.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25653 Yates*, December, 1916. On bark of dead trees in the forest.

HYPOXYLON MARGINATUM (Schw.) Berk. Cuban Fungi No. 830.

Sphaeria marginata Schw. in Syn. Am. Bor. No. 1176.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25653, 25623 Yates*, December, 1916. On bark of dead trees in the forest.

HYPOXYLON CADIGENSIS sp. nov.

Stromatibus superficialibus, hemisphaericeis, atris, gregariis, 7-10 mm diam.; peridium atrum, 150-180 μ crassum, intus albidus; peritheciis numerosis, globosis, circiter 1 mm crassis; ascis cylindraceis, 150-160 μ longis, 12-15 μ latis, pedicellatis, aparaphysatis; sporidiis monostichis, ellipsoideis, inaequilateralibus, utrinque acutis, fuligineis, 20-23 μ longis, 8-10 μ latis.

LUZON, Tayabas Province, Mount. Cadig, *Bur. Sci. 25807 Yates*, December, 1916. On dead logs in the forest.

NUMMULARIA Tulasne

NUMMULARIA ALABATENSIS sp. nov.

Stromatibus primo subcutaneis, mox erumpentibus, applanatis, carbonaceis, intus et extus nigris, oblongis vel irregularibus, 1-2.5 x 3-10 cm; peritheciis monostichis, subglobosis, 200-300 μ diam.; ascis cylindraceis, evanescentibus, 75-85 μ longis, 7 μ latis, octosporis; sporidiis monostichis, ellipsoideis, utrinque rotundatis, non septatis, fuligineis, 10-11 μ longis, 5 μ latis.

ALABAT, back of Sangirin, *Merrill 10515*, December 25, 1915. On dead trunks in the forest.

NUMMULARIA REYESIANA Rehm in Leaf. Philip. Bot. 8 (1916) 2960.

LUZON, Tayabas Province, Mount Cadig, *Bur. Sci. 25760 Yates*, December, 1916. On dead stems of bamboo.

KRETZMARIA Fries

KRETZMARIA GHOMPHOIDEA Penz. et Sacc. in Icones Fung. Jav. (1904) 27.

LUZON, Tayabas Province, Basiad, *Bur. Sci., 25678 Yates* December, 1916; Mount Cadig, *Bur. Sci. 25794 Yates*, December, 1916. On rotten wood in forests.

The spores in the above specimen are 7-8 x 4-5 μ, being slightly smaller than those of the type from Java which is described as having spores 8-10 x 5-6 μ. This species has not been previously reported from the Philippines.

XYLARIA Hill

XYLARIA CONIFORMIS Fr. in Summ. Veg. Scand. (1846–1849) 381.

ALABAT, back of Sangirin, *Merrill 10549*, December 21-30, 1916. On rotten logs.

XYLARIA LUZONENSIS Henn. in Hedw. 32 (1893) 225.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25594 Yates*, December, 1916. On dead pods of *Bauhinia* lying on the ground in dense forests.

This species of *Xylaria* seems to occur only on the pods of *Bauhinia*. It has been collected several times, but always occurs on the same substratum.

XYLARIA SETOCEPHALA sp. nov.

Stipitata, gregaria, minuta, stipitis 12-14 mm longis, 0.25-0.5 mm diam.; peritheciis paucis, ad 30-40, capitulis atris, subglobosis vel ellipsoideis, 1-5 mm longis et 1-2.5 mm latis; ostiolis punctato-asperulis, seta apicalis 5-8 mm longis; ascis cylindraceis, apice rotundatis, stipitatis, paraphysatis, 89-100 x 7-8 μ, octosporis; sporidiis monostichis, ellipsoideis, 13-15 x 6-8 μ, fuligineis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25647 Yates*, December, 19, 1916. On fallen leaves of *Garcinia* sp.

This species is distinguished by the long terminal seta. In general habit it resembles *Xylaria oocephala* Penz. et Sacc. as figured in Icon. Fung. Jav. (1904) *t. 22, f. l.*

SPHAERIOIDACEAE

PIROSTOMA Fries

PIROSTOMA ARENGAE sp. nov.

Pycnideis numerosis, superficialibus, punctiformibus, atris, 0.25-0.5 mm diam., ostiolis minutis, 20-30 μ diam.; 1-locularibus; basidiis non visis; sporidiis brunneis, ellipsoideis 9-11 μ longis, 5-7 μ latis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25612 Yates*, December 20, 1916. On the dead petioles of *Arenga* sp.

PHYLLOSTICTA Persoon

PHYLLOSTICTA ALLOPHYLAE sp. nov.

Maculis amphigeneis pallescentis, orbicularibus vel suborbicularibus, 2-4 cm diam.; pycnidiis gregariis, epiphyllis, erumpentibus, punctiformibus, atris, lenticularibus, 100-150 μ diam., pertusis; ostiolis orbicularibus, 5-7 μ diam.; contextu brunneo; sporidiis subglobosis, laevis, 3 μ longis, 2 μ latis.

ALABAT, back of Sangirin, *Merrill 10535*, December 25, 1916. On the leaves of *Allophylus timorensis*.

This *Phyllosticta* grows on the living leaves, apparently starting near the margin or tip and advancing inward and killing the leaf in more or less concentric circles. The dead leaf surface is dotted with the small black pycnidia.

MELANCONIACEAE

MELANCONIUM Link

MELANCONIUM CALAMI sp. nov.

Acevulis orbicularibus, atris, primo subcutaneis, mox erumpentibus, 0.5-1.0 mm diam.; conidiis obscure brunneis, ovatis, subglobosis vel angulatis, 8-10 μ longis, 5-7 μ latis; basidiis non visis.

LUZON, Tayabas Province, Basiad, *Bur. Sci. 25696 Yates*, December 19, 1916. On dead leaf rachis of *Calamus*.

DEMATIACEAE

CERCOSPORA Fresenius

CERCOSPORA GLIRICIDIAE Syd. in Philip. Journ. Sci. 8 (1913) Bot. 283.

LUZON, Manila and vicinity, *Bur. Sci. 25383 Yates*, August, 1916. On the leaves of *Gliricidia sepium*.

CERCOSPORA PERSONATA (Berk et Curt.) Ellis in Journ. Myc. 1 (1885) 63.

Cladosporium personatum Berk et Curt. in Grev. 3 (1875) 106.

LUZON, Manila and vicinity, *Merrill 7417*, November-December, 1910. On leaves of *Arachis hypogaea*.

HADRONEMA Sydow

HADRONEMA ORBICULARE Sydow in Ann. Myc. 7 (1909) 172.

LUZON, Benguet Subprovince, *Bur. Sci. 25166 Yates*, March-May, 1916: Ifugao Subprovince, *Bur. Sci. 25267 Yates*, April, 1916. On living leaves of *Quercus* sp.

This species was originally described from Japanese material where it grows on the leaves of *Quercus*. In 1910 Sydow referred *Bur. Sci. 8711 McGregor* to this species. This specimen was collected on *Quercus* at Pauai, Benguet. I found it to be quite common on the leaves of *Quercus* at higher elevations in the Mountain Province in northern Luzon. It is interesting as one of the few species known to occur only in Japan and the Philippines.

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[New generic and specific names and new combinations are indicated by **black-faced type**; synonyms and names of species incidentally mentioned in the text are in *italics*.]

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